THE

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THE

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SOME SPECULATIVE POINTS.

IN a recent address, Prof. W. Ostwald, with whose classical researches our readers are well acquainted, turned aside from his usual academic style and indulged in a few remarks concerning some problems which to-day are only of speculative scientific interest, but which may, in the near future, easily develop into technical and commercial importance. He called attention to the great waste of energy which goes on even in the best forms of the steam-engine, owing to the loss of heat between the stoke-hole and the boiler, and again between the boiler and the engine. This is a favourite subject for attack, but the professor, as might have been anticipated, invested it with interest anew. He pointed out that of the energy of the coals consumed, only about ten per cent. is realised in the way of mechanical work in the very best types of engines. Gas engines may, he thought, remedy this waste to some extent, but he looked rather to the electrical transformation of the energy of fuel. In this direction, the professor very shrewdly remarked, all attempts at the direct union of coal and atmospheric oxygen must fail. He illustrated his argument by an experiment with a divided cell containing zinc and platinum plates in a solution of potassium sulphate; no current is set up in this arrangement until acid is added to the liquid, and this acid which is to act upon the zinc must be added to the compartment in which the zinc is not, for electro-chemical reasons. He then indicated the coal-cell of the future, containing coal in the one part and the oxidising material in the other (which must be atmospheric oxygen or something easily and cheaply obtained from it), and containing possibly an electrolyte for purposes of conduction which must undergo no permanent change. The professor then passed to the consideration of the secondary battery and pointed out that since the energy in an accumulator is proportional to the quantity of electricity and the E.M.F., and since the former depends upon the electro-chemical equivalent of the material employed, attempts should be made to utilise in accumulators a metal of low equivalent in order to economise bulk and weight. With regard to electrolysis, he expressed himself as of opinion that the ordinary distinction between primary and secondary reactions is to a great extent arbitrary and meaningless, for the E.M.F. needed for electrolysis is always that agreeing with the actual products, not that calculated for the imaginary ions, which are supposed afterwards to form the actual products by "secondary actions." He distinguishes between the electrolytes which aid in conveying the current and those which are separated at the poles: the current strength will depend upon the resistance to which all the substances present contribute, according to their mass or concentration and their ionic speeds; but the polarisation at the electrodes is conditioned only by what deposits there. It is not often that Professor Ostwald steps out from the

region of pure research in which his mental energies are chiefly concentrated, but the sample which he has given us of a wide breadth of view and a strong grasp of practical economies in his address on the scientific and technical electro-chemistry of the present and future leads us to hope that he will more frequently be heard on this subject.

ALTERNATING CURRENT NOMENCLATURE.

Judging from the letters which have recently appeared in the American technical press, the nomenclature for alternating currents is still in an unsettled condition. The discussion has turned to a large extent on the meaning to be ascribed to the term "reactance." It is doubtless desirable to have a name for the part of the E.M.F. concerned in all so-called "wattless" currents, whether due to capacity, self-induction, &c., and from this point of view the word "reactance" will do as well as any other. It is of course common knowledge that the apparent self-induction of transformers diminishes, and the apparent resistance increases in the primary, as the load increases on the secondary, and that similar effects occur throughout the field of alternate current work, and if the proposed terms "apparent resistance" for the factor concerned in the absorption of energy by ohmic effects, and "reactance" for the wattless volts were agreed on, it would help to keep matters, which often get hazy, clear in the mind. It is not, however, necessary to drag in long disputes based on what has been well termed "iron-less mathematics" in order to define the quantities concerned. Such iron-less mathematical definitions and deductions are quite useful in their proper places, such as for scientific papers, and for teaching students who are unfamiliar with the phenomena of alternating currents, but for practical definitions and ideas it is quite possible to do without them. We can manifestly always consider the E.M.F. of supply in any alternating current apparatus as broken up into two components, the one in phase with the current and of such a magnitude as to account for the total consumption of energy due to resistance, eddy currents, hysteresis, and energy absorbed in such a circuit as the secondary of a transformer, and the other component at right angles to this. The phase angle between the impressed E.M.F. and this apparent effective one is evidently a determinate amount, even though it may never, at any part of the cycle, be the actual angle existing between the current and the impressed E.M.F.

REASONS WHY PRICES ARE LOW.

The *Engineering Magazine* has always exhibited a tendency to discuss financial and economic rather than purely engineering questions, and its manner of discussion and general temper are altogether those of the soulless "natural law" man, who would shut out sentiment entirely. This sort of thing may be all very well in this country where the natural law is allowed a free course untrammelled by any nonsense of tariffs, but to find high tariff men thus arguing is ridiculous indeed. Americans as a mass are steeped in the densest ignorance of economic facts, and articles dealing with such subjects are simple balderdash, while no American writer appears to have the courage to tell his countrymen of their follies, or if he has the courage, he can find no publisher to give him space.

The article under review, by Albert Williams, Jun., is very much in the usual American style, but we fail to gather from it any explanation whatever of why prices are low. We read that there is over-production of wheat. This is sheer nonsense. How can there be an over-production of wheat when thousands are wanting more of it than they can get. Clearly our author is one of the class who would cheapen production all round by a reduction of wages to the minimum, and then he would sit down and howl that there were no purchasers of luxuries. Put as briefly as possible, prices go low as a result of ill-considered and dishonest speculation. Credit is shaken, a bad time is anticipated, and people suddenly become thrifty in preparation for the rainy day which comes all the more completely and quickly by reason of this very preparation for it. The Socialist view of thrift as a crime is undoubtedly perfectly sound. Once get men to believe that they and their families were assured an honourable existence under all circumstances, and thrift would cease, money would be freely spent as soon as earned, and trade would be maintained in a uniformly steady condition, all articles going into consumption in a steady stream. But the Socialist view cannot be realised, unless accompanied by a very drastic and uncompromising compulsory labour rule, and it is just this absolutely necessary item of work that is so distasteful to the man whose idea of socialism includes idleness for at least No. 1.

The Propagation of Electric Waves in Ice.

Two years ago in a paper communicated by Mons. Blondlot to the Paris Academy of Science, he enunciated the following proposition :—The length of the waves which an electro-magnetic oscillation can emit, is the same whatever be the insulating medium in which the experiment is made ; in other words, the wave length depends upon the oscillator alone, just as in acoustics the wave length of a pipe depends only on the length of the pipe. From numerous experiments made with very different substances, it appears that this law holds good generally. There has, however, been a doubt about ice in consequence of the exceptional properties ascribed to it. For example, MM. Bouty and Perot has shown that ice has a dielectric power of 27, that is to say, incomparably greater than that of all other substances. Suspecting that a law relative to the propagation of waves might not apply to a dielectric so different from others, Mons. Blondlot resolved to submit the question to experiment. At a recent meeting of the Academy of Science he published the results of his investigation. Briefly, he finds that ice does *not* possess exceptional dielectric properties, and the proposition relative to the wave length is, therefore, true for ice as well as for other dielectrics. Hence, Maxwell's relation that the dielectric power is also equal to the square of the refractive index also holds good for electro-magnetic waves. It remains to be explained how MM. Bouty and Perot obtained values of so completely different an order for the dielectric power of ice. We note, however, that in the experiments by which their results were obtained, the charge and discharge were enormously slower than in Mons. Blondlot's experiments.

ARMATURE FAULT-TESTING.

R. P. BROUSSON, A.I.E.E.

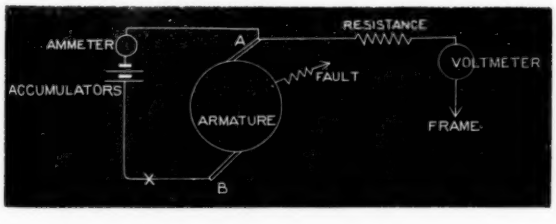
When the insulation between two or more adjacent sections of the winding of an armature breaks down, and a partial or dead short circuit occurs between those sections, there is no difficulty in testing and locating the position of the faulty coils. If the resistance of the fault were so low that a dead short circuit had occurred, the damaged condition of the insulation of the faulty coils would probably be sufficient indication of their position; if, on the other hand, there had only been a partial short circuit, the current not being sufficient to damage the insulation of the coils as a whole, it is necessary to test the armature. The method usually employed is to pass a suitable large current through the armature from brush to brush, and to measure the fall of potential between the different commutator segments; the P.D. measured at the segments attached to the faulty coils will be slightly or much smaller, depending on the resistance of the fault, than the P.D. between the perfect segments.

When the insulation of an armature coil breaks down to the frame of the machine, the locating of the fault, if it is not visible, is more difficult, the usual method being to unsolder the connections to two diametrically-opposite segments, and then testing to see in which half of the armature the fault lies, and to go on sub-dividing and testing until the faulty section, or sections, are isolated.

The writer quite recently employed a method by which it is possible to locate the position of the faulty coil, that has the advantage that no unsoldering of the connections whatever is necessary. As far as he is aware the method is new, or, if not, is certainly not generally known.

A suitable current is passed through the armature from brush to brush, of such magnitude that there is a measurable fall of P.D. between the commutator segments, care being taken that the brushes do not make contact with more than one segment at a time.

One terminal of a low reading high resistance voltmeter or galvanometer is connected to one brush, and the other terminal to the frame of the machine, as in diagram. The most suitable



voltmeter to employ is a high resistance D'Arsonval galvanometer, the sensibility of which can be altered by means of an adjustable resistance placed in series with it. As the resistance of the fault, which can of course vary between wide limits, is in the voltmeter circuit, it is thus advantageous to be able to alter the sensibility to give suitable readings.

The armature is now slowly turned by hand until that position is reached where the voltmeter records the *smallest* obtainable deflection. The commutator segment, to which the faulty coil is attached, will then be under the brush, A, for by thus turning the armature until the minimum deflection is obtained, the two ends of the voltmeter circuit are brought nearer and nearer together until they finally coincide. The maximum deflection will be obtained when the fault is farthest away from the brush, A, that is, when connected to the brush, B.

If the connection to frame is at the commutator segment itself, the smallest deflection will be zero, because the galvanometer will be short-circuited through the fault; but if the fault, as is usually the case, is in one of the two coils connected to the segment, then there will be a small difference of potential at the ends of the voltmeter circuit, and possibly a small deflection on the galvanometer. To ascertain which of the two coils connected to a segment is faulty, the deflection on the voltmeter must be carefully noted, when the brush touches the segments on each side of the one from which the lowest reading was obtained. The faulty coil is the one connected between the two segments, which give the two lowest readings. If the breakdown in the insulation occurs exactly in the centre of a coil, the two smallest deflections will be equal.

If the insulation has broken down in two distinct parts of an armature, the fact will at once be apparent, because the deflections on the voltmeter will not increase or decrease regularly in all positions as the armature is turned round.

When the two faults occur close together, there is no difficulty in locating the position of the coils, at any rate very nearly. It is not so simple, however, although possible, by a modification in this method of testing, to determine the position of two faults which are *far apart*.

It is perhaps interesting to note that the insulation resistance of the defective coil can also be approximately measured without materially altering the connections, first by noting the maximum deflection, D_1, obtained when the voltmeter is connected through the fault, and then also the deflection, D, obtained when the voltmeter is connected straight across the two brushes.

Calling R the total resistance in the voltmeter circuit, excluding the fault resistance, then the resistance of the fault will be approximately equal to $\frac{D \times R}{D_1} - R$.

THE FUTURE OF ELECTRIC TRACTION IN THIS COUNTRY.

By PHILIP DAWSON.

The report of the Committee of Conference on Light Railways, called together by the Board of Trade, coupled with the recent decision of the London County Council, not to sanction the use of electricity on the Acton and Shepherd's Bush branch of the London United Tramways Company, Limited, deserves notice.

The engineering and electrical Press have already commented at length on these matters, and it is the purpose of this article to review, compare the opinions given, and to draw such conclusions therefrom as may seem warranted. In the opinion of the writer, these conclusions justify the belief that the general adoption of electricity as the accepted best motive power for our tramways—and for most, if not all, of our light railways—is a certainty.

Electric traction is undoubtedly in the air. The *Engineer*, and *Engineering*, devote special attention to it; the engineering societies have discussed the subject at greater length than ever before, and the distinctively electrical journals are full of it. England seems at last awake to the fact that the days of horse tramways are numbered, and the only question now is as to what mechanical power shall replace animal power. In England, at least, unanimity on this point does not yet exist.

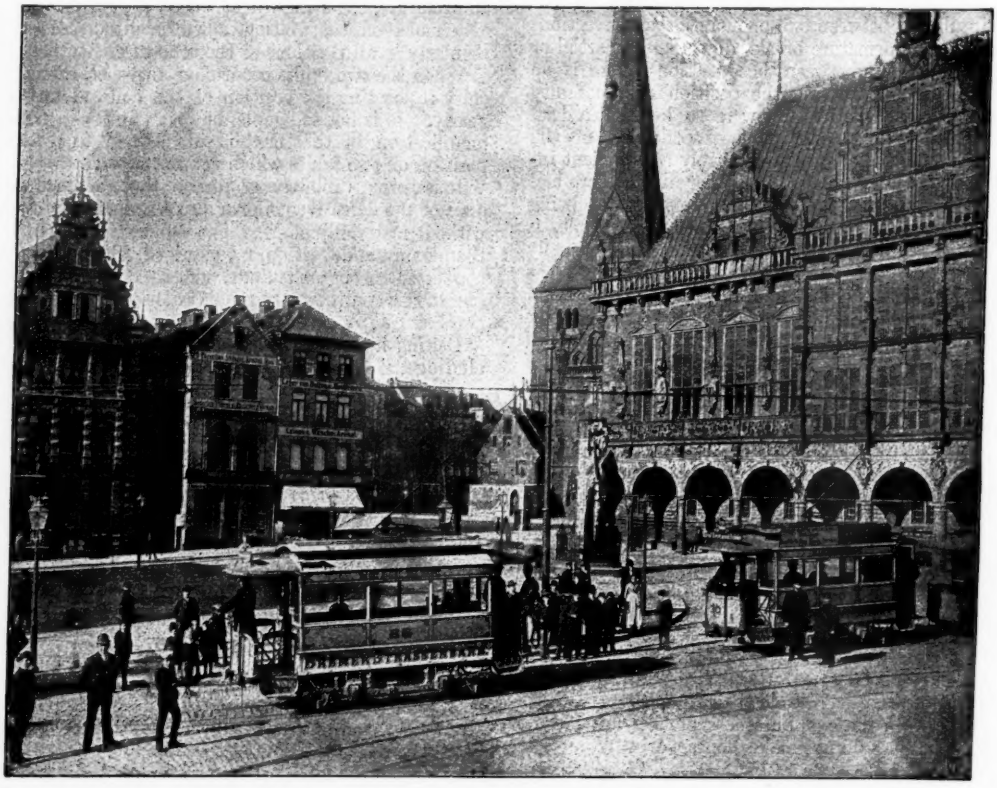
Engineering pointed out in their leader of February 8th, that light railways are a recognised necessity, if the absolute ruin of our agricultural population is to be averted.

The Queen's Speech promises the introduction of a measure to facilitate their construction on the same general plan as has already been adopted on an extensive scale and with marked success on the Continent of Europe. The memorandum annexed to the report made by the committee on light railways, and signed by Mr. W. J. Carruthers Wain and Mr. Stephen Sellon, tells us that there are nearly 9,000 miles of such lines in operation on the Continent. We have therefore every reason to expect that a certain number of such lines will be constructed in the near future.

The *Engineer*, in a leader of February 8th, is not sanguine, and does not foresee the success of light railways, or the need of them.

It is stated therein that as our country is intersected with railways and canals, and as we have good horses and roads, we require no other mode of conveyance. A similar argument was used against the introduction of railways in the thirties. The question of speed and working cost seems to have been left out of consideration.

The journals, however, all agree on one point, viz., that



Market Place, Bremen.—Line Constructed by the Union Electricitats Gesellschaft, Berlin.—Thomson-Houston System.

Klingenberg Lubeck.—Road Built by the Allgemeine Elektricitats Gesellschaft, of Berlin.

the cost and waste of time incurred in Parliamentary procedure must be done away with, and the present complicated method of obtaining franchises greatly simplified. Under the existing system, when a small line is in question, the necessary legal and Parliamentary costs, greatly exceed the cost of construction and equipment. This has been the cause of many small, but locally beneficial, schemes being abandoned.

We do not find the same unanimity when we come to the question as to the mode of traction best suited to light railways, and urban, suburban, and inter-urban tramways.

The *Pall Mall Gazette* objects to the use of the overhead trolley in highways of such æsthetic value as the Uxbridge Road; lest we "spoil our streets" by "gigantic pillars," and prefers horses, the cable, and steam, because they are "sightly methods of locomotion!" It seems difficult, indeed, to find anything "sightly" about the Leeds and Birmingham steam trams, not to mention smoke, noise, and dirt.

At the meeting of the County Council to consider whether the use of the trolley should be allowed on the Uxbridge Road between Shepherd's Bush and Acton, Mr. J. Williams Benn, M.P., feared that the denizens of London would be "deprived of the blue (?) sky above," characterised the American trolley roads as "monstrosities," and stated that the centre of the street became a "metallic cobweb."

Mr. John Burns, M.P., said that a trolley road would "destroy the beauty of the district" (!) and that "where the system had been adopted the value of the surrounding property had greatly depreciated," and that it "would obstruct the passage of the fire escapes."

It is probably unnecessary to devote much space to a discussion of how far æsthetics enter into the traction question. It can scarcely be urged in good faith that English streets can be "disfigured" by the introduction of a system already employed by every American city, and by many of the most beautiful and artistic of Continental towns. Such rant as has issued from the lips of Messrs. Burns and Benn can only be inspired by ignorance.

As Mr. Ferranti has already urged before the Institute of Electrical Engineers, a modified form of fire escape is necessary. In America, where fire is a far greater danger than in this country, owing to the height of the buildings and to the extensive use of wooden constructions in some of the smaller cities, it never occurred to the American mind that the proper way of carrying a ladder was in the perpendicular position. It is quite time that we discarded the cumbrous and dangerous upright fire escape, and adopted the American and Continental "hook and ladder" truck drawn by horses, and called to fires in the same manner as the engines themselves.

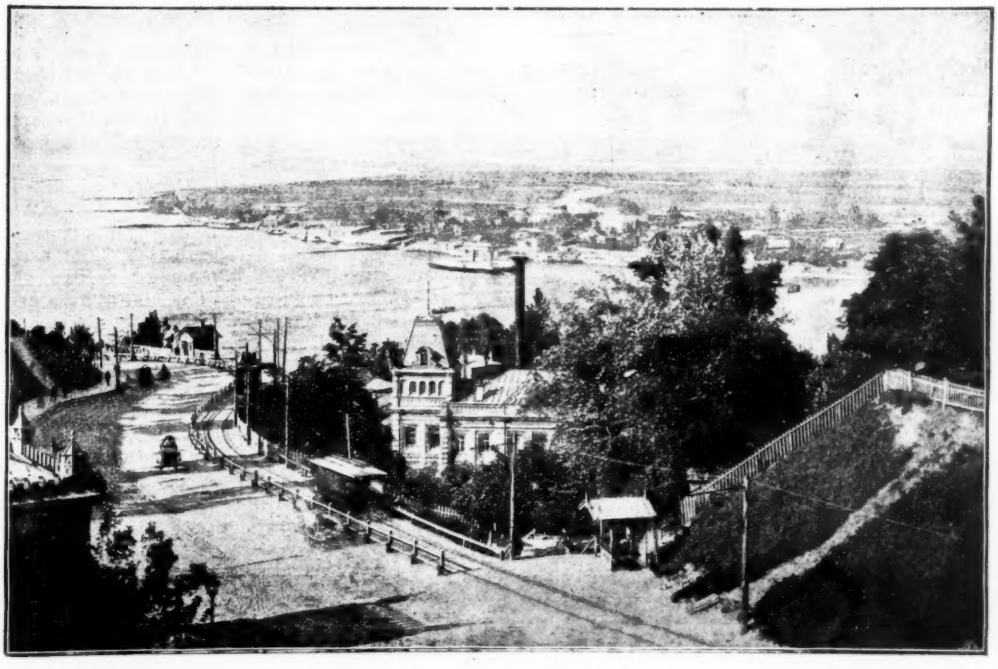
It is a notorious fact that the value of land has invariably increased with increased rapid transit facilities, whatever their nature.

The large railroad companies and assurance societies are among the heaviest investors in electric tramways in the United States, and the street car is there the recognised democratic mode of transportation. We wonder at Mr. John Burns making such gross mis-statements, especially after visiting the United States. A little knowledge is certainly a dangerous thing.

The other objections are, we think, sufficiently answered by the accompanying illustrations.

The following are brief details of the installations:—

Bremen.—Equipped by the Union Electrical Company on the "Thomson-Houston" system. Ten miles of track; 25 motor cars; 450 H.P. at station. This line has been most satisfactory, the electric surface having larger receipts, and being run at 28 per cent. less than the horse cars in the same town.



Kiew, Russia.—Line Constructed by the Allgemeine Electricitats Gesellschaft, Berlin.

Lubeck.—Equipped by the "Allgemeine" Electrical Company, of Berlin. 8½ miles of track; 44 electric cars; 450 H.P. at power house.

Kiew.—The first town with an electric tramway in Russia, equipped by the "Allgemeine," of Berlin. 8¾ miles of track; 32 motor cars; 600 H.P. at power house; grades of 1 in 10.

We should like to call the attention of Mr. John Burns, as a friend of the people, to the remarks of Prof. Silvanus Thompson, F.R.S., at the Institution of Electrical Engineers: "The overhead construction which least disfigures the landscape is that of the modern trolley line." The cheap and rapid transit furnished by the trolley lines enable the "workmen, instead of crowding into barracks and tenements," to "live in little workmen's villas, each standing in its own separate plot of ground," and "where true civilisation is much more possible." These statements Prof. Thompson makes after having but recently visited America.

Electricity enables a cheaper working and far superior service, so the following data, furnished to the writer by the

courtesy of the British Thomson-Houston Company, Limited, may be of interest in this connection:—

Working Expenses of Roundhay Tramway.

Power House Expenses.	Pence per car mile.	
Wages	0·533	
Fuel, water, gas	0·736	
Oil waste stores	0·091	
Maintenance	0·092	
		1·452
Transportation.		
Drivers' wages	0·869	
Oil, waste, water, gas and stores	0·081	
Cleaning cars and track	0·435	
Repairs of cars	0·155	
Repairs of line	0·009	
		1·549
Office and General Expenses.		
Wages of conductors	0·705	
Salaries and management	0·663	
Rent, rates, taxes and insurance	0·461	
Postage, stationery and miscellaneous ...	0·167	
		1·996
Total cost per mile		4·997

The following figures, which need no explaining, are of interest as showing the economy of electric traction:

Table giving Pounds of Coal per E.H.P Hour at Switchboard.

Salt Lake City—Compound high speed non-condensing engine...	6·3 lbs.
St. Louis—Corliss non-condensing engine... ...	4·50 lbs.

Table giving Coal Consumption per Car Mile.

	Type of Engine.	
Breslau	... Compound condensing ...	... 4·63 lbs.
St. Louis	... Corliss non-condensing ...	... 8·57 lbs.
Marseilles	... Corliss	... 7·22 lbs.

From a large number of figures, it would seem that in England an average of from 5 to 6 lbs. of coal per E.H.P. furnished at switchboard would be a safe figure to assume.

The average E.H.P. per car at the switchboard on a tramway, gradients not exceeding 1 in 15 can be taken as from 7 to 12 E.H.P.

That electric traction fulfils a want which no other system has ever filled, is proved by the table showing its extension in Europe and America. The very large investment required for a cable road is practically prohibitive in all but exceptional cases, for it is seldom that traffic is heavy enough to warrant an investment of from £18,000 to £50,000 per mile of track.

Table Showing Progress of Electric Traction in America.

	End of 1890.	End of 1894.
Mileage: Electric ...	2,523	9,008
horse ...	5,400	2,243
cable ...	510	662
steam ...	604	614
Total	9,037	12,527
No. of cars: Electric...	5,592	24,849
horse ...	21,970	11,507
cable ...	3,795	4,673
steam ...	751	639
Total	32,108	41,668

The above figures speak for themselves, and are more convincing than any long arguments could be.

Table showing Electric Trolley Lines which are now Running in Europe, or are under Contract for Immediate Equipment.

Name of town.	Miles of track.	No. of electric cars.	H.P. in power houses.
Germany	430	1,330	17,200
France	120	250	7,300
Great Britain	93	170	6,700
Austria-Hungary ...	75	170	3,500
Switzerland	35	50	2,000
Italy	33	85	2,500
Belgium	22	45	1,300
Other countries... ...	42	120	1,800
	850	2,220	42,300

United States and Canada Electric Roads.

Miles of track, 9,000. No. of cars, 25,000. H.P., 850,000.

The trolley car and the trolley wire have come to stay, and it is utterly futile to endeavour to stem the tide of progress.

After three years' experience with elevated conductors, the Corporation of Leeds have voted to adopt the trolley for nearly the whole Leeds system.

In South Staffordshire the people along the electric line are delighted with the service, and the directors report that this line is worked 3d. per car mile cheaper than the steam lines in the same district. After most careful investigation the corporations of Bristol and Dublin have approved the trolley system. Surely the Uxbridge Road is not finer than the main streets of these cities.

It is to be hoped that the County Council will live and learn, and will at no distant date repent of and reverse its resolution. Tramways are the conveyance of the masses, an essential requisite of modern metropolitan existence, and their extension and efficiency should be insisted upon, instead of antagonised by all those who claim to have near at heart the interests of the public at large.

Faddists and demagogues may find it to their interest to block the schemes for increased rapid transit, but the English public may be relied upon to insist, at no distant day, that it be given at least equal advantages to those now enjoyed by the denizens of other cities of the civilised world. Now we are lamentably behind, and it is an utter absurdity to account for one not having ordinary facilities by such ridiculous statements as are put forward by those advanced æsthetes, Messrs. Benn and Burns.

ELECTRICALLY-DRIVEN CENTRIFUGAL MACHINES.

Centrifugal machines are particularly suitable to the direct application of electrical power, and, when so driven, present many advantages on the side of true economy on account of their high speed, and the intermittent character of the work they are called upon to do.

The constant current motor, however, has shown itself unpractical for this purpose, partly because it has been almost impossible to overcome "sparking" on account of the vibration set up in the spindle, partly because the continuous attention rendered necessary by its commutators and brushes become almost impracticable, owing to the situation of the motor beneath the spindle.

All these drawbacks disappear where the three-phase motor is adopted, there being in this neither commutator nor brushes, it possesses several further important qualifications, which combine to make it, under all conditions, the most reliable and suitable motor for centrifugals for any kind of work.

Firstly, it maintains its speed better than the constant current machine under any circumstances, inasmuch as its revolutions vary only subject to a variation in the speed of the steam engine; hence there is no trouble beyond that common to such machinery, namely, the proper control of the engine itself.

Further, this "three-phase motor" is capable of running

under a more excessive load than any constant current motor of similar wall power, an absolute necessity for centrifugals, by reason of the large dead weight to be set in motion. This supreme advantage is attained by a special construction of the armature.

If, as is generally the case, the plant consists of a considerable number of centrifugals, then those already in motion assist, by their momentum, such as may subsequently be started, just as is the case where ordinary gearing is used, and thus support the motor to be thrown into gear; *e.g.*, should an increase of load occur in the engine room, then first the steam engine and then the dynamo will show the

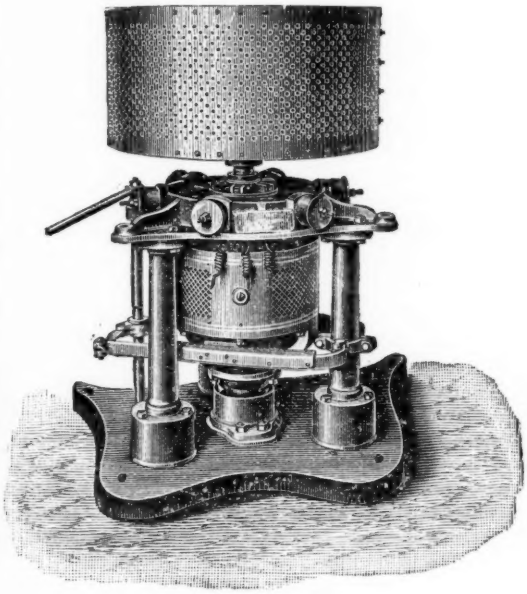


Fig. 1.

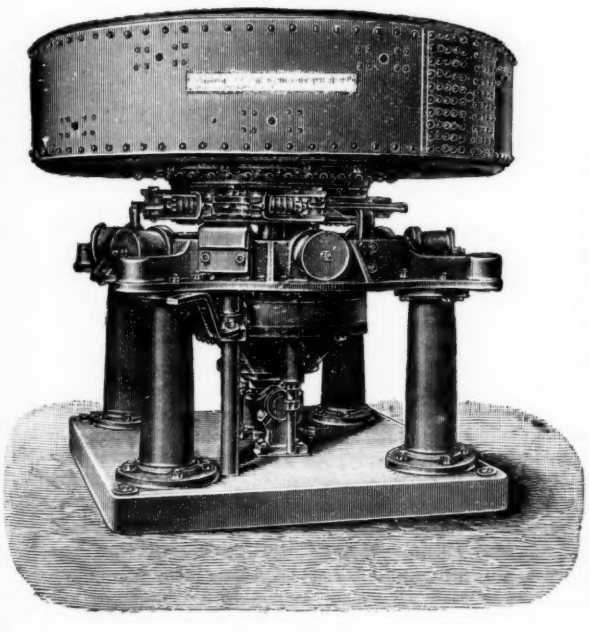


Fig. 2.

tendency to drop their speed to some extent. The centrifugals, and the electromotors attached to them, are, however, by their momentum, compelled to maintain their former speed, and thereby work for the moment as dynamos, thus assisting the prime generators.

The "three-phase motors" of the Electrical Company, Limited, for centrifugals are up to the present made in the following sizes:—

Type.	Approximate revolutions per minute.	Approximate H.P. at full speed.
D R.C. 20	1,000	1
D R.C. 50	1,000	2½
D.R C. 80	700	4
D.R C. 99	700	7
D.R.C. 100	500	5

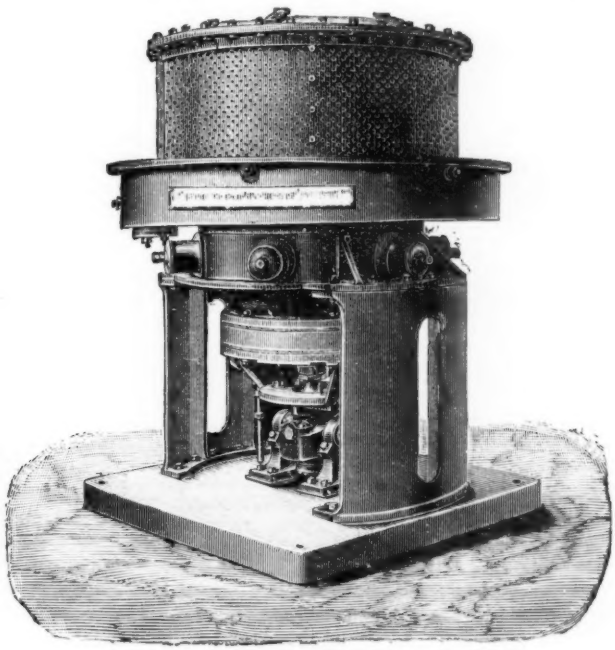


Fig. 3.

Every centrifugal machine consists in general of an outer casing or shell, within which revolves around a vertical spindle, the basket; nevertheless, individual designs differ in details of construction, according to the method adopted in the erection of the shells and the attachment of the spindle-bearings, and may be divided into four groups.

In the first the upper bearings are connected by tie-rods between India-rubber buffers to the fixed casing or shell, whereas the lower back bearing is provided with a universal joint, &c., so as to be able to follow the oscillations of the spindle. Here, therefore, the shell is stationary, the pan and its spindle is given the requisite play. As the armature of the electromotor is fitted direct upon the spindle, yet the space between armature and pole ring must not exceed a few millimetres; the latter is so fixed that it can participate with armature and spindle in the oscillations, for which reason it is connected by arms with both upper and lower bearings.

This arrangement has been adopted in, among others, hydro-extractors in the textile industry; fig. 1 is of great importance in sugar mills. The economy and other advantages of driving their centrifugals by electricity has quickly become manifest after the introduction and publication of the results of one such pan driven by one of this type of motor.

Fig. 2 shows a large centrifugal for loaves, which has been fitted with electric motive power, in accordance with the arrangement above described, for the first group; fig. 3 represents a somewhat smaller kind, similar in mechanical details to those referred to in fig. 1, and fitted with patent oil pressure bearings.

A second group of centifrugals are those in which the spindle bearing is rigidly affixed to the casing, and the whole affair rests upon the lower pivot bearing, while the casing itself has all the requisite play.

A third group consists of those in which both casing and spindle bearing are rigid, and in which is placed the pole ring of the motor direct within the pan casing.

The fourth group comprises the Weston pan, which consists of a rod, hanging downward, perfectly free at its lower

end, and which does not revolve. At the upper end of this rod is a spherical bearing; over this rod is slipped the spindle (in this case hollow) of the centrifugal, and this carries the armature of the motor. The well-known firm of sugarworks engineers, Messrs. Watson, Laidlaw & Co., of Glasgow, are making the mechanical portion of this type.

As an illustration of the great importance to the sugar industry of this new development in the construction of electromotors, we may state that immediately after the results of the experiment above alluded to had become known, three large sugar manufactories on the Continent placed orders for the erection of electrically-driven centrifugals, and resolved to adopt electrical transmission by means of these three-phase motors for other portions of their plant. One of these firms, having commenced the reconstruction of their works, have determined to introduce electric power throughout, and to apply these motors to every machine and apparatus in motion. For these plants 94 motors, with an aggregate of 500 H.P., are required, which, for the most part, are coupled direct to the respective machines by new and original means.

CRITICISM?

WE do not claim any originality in putting a contemporary in parallel; it has been done before, with conspicuous success. Critics, like some other persons, ought to have good memories. We have been frequently taunted with indulging in destructive criticism. We give the following as examples of another kind of criticism:—

When the new gas was brought before the British Association by Lord Rayleigh and Prof. Ramsay, we said, among other things:—

(ELECTRICAL REVIEW, *August 24th*, 1894.)

"We are under a strong impression, however, that in this instance they have surrounded their 'discovery' with more mystery, if not glamour, than the occasion warrants . . . . Lord Rayleigh and Prof. Ramsay may have obtained an allotropic form of nitrogen, or have been examining this well known gas under conditions new to them. . . . . In all probability all that has been isolated is an allotropic form of nitrogen. . . . . We find ourselves brought to the same conclusion as Prof. Dewar."

ELECTRICAL REVIEW.

Still consistent, we said on *December 7th*:—

"It is clear from Lord Kelvin's address at the anniversary meeting of the Royal Society on December 1st, that he accepts, without reserve, the discovery of a fifth constituent of the atmosphere by Lord Rayleigh and Prof. Ramsay. He regards it as the greatest scientific event of the past year, and looks forward 'with impatience' to a complete exposition of the chemical and physical properties of this anonymous gas. . . . . It was noticeable that Lord Kelvin did not as much as allude to the scepticism with which distinguished chemists and physicists received the Oxford announcement. . . . . We are driven, therefore, to the conclusion that Lord Kelvin must have had private opportunities of weighing evidence in favour of the new gas which we and the public generally have not. . . . . The actual evidence yet given to the world by Lord Rayleigh and Prof. Ramsay concerning their new gas is so scanty and of such a character *that our verdict must still be 'not proven.'*"

Following a long way behind, like a meek and mild female sheep, our contemporary says:—

(*August 30th*, 1894.)

"In an article on the 'New Gas,' the ELECTRICAL REVIEW *wisely* says ditto to Prof. Dewar, *i.e.*, it holds that Lord Rayleigh and Prof, Ramsay have been manufacturing allotropic nitrogen, not isolating a new element present in the atmosphere."

Still consistent, our contemporary followed (*Lightning, December 13th*, 1894):—

"A leaderette expresses some surprise that Lord Kelvin should actually 'accept without reserve' the discovery of a new gas, at which the ELECTRICAL REVIEW had thought fit to mock. Lord Kelvin must have some evidence of the reality of the discovery other than that produced by Lord Rayleigh and Prof. Ramsay, or he would never 'permit himself to hold, much less to express, this attitude'—*express this attitude* is good. Still, the ELECTRICAL REVIEW, 'placing this aside,' gives a verdict of 'not proven,' in which verdict *we concur*, without even the ELECTRICAL REVIEW'S reservation."

Then came a lightning-like change of front. (*Lightning, February 7th*, 1895):—

"We search the pages of the ELECTRICAL REVIEW in vain for some comment on the 'new gas.' Perhaps we shall find it in the coming number, or is it that our contemporary is at a loss how to cover its retreat from its position of scornful incredulity."

ELECTRICAL REVIEW, *February 8th*.

"The large, distinguished, and unprecedented meeting of the Royal Society on January 31st received the paper on 'Argon: A New Constituent of the Atmosphere,' with enthusiasm, and although so many eminent personages were there, the absolute failure of the faculty of criticism on that occasion forms one of the most curious episodes in the history of the Royal Society of London. . . . . Thus actual experiment indicates that the real proportion of argon in the air is only about 0·05 per cent. by volume; and we are driven to the conclusion that the difference of density between the nitrogen of the air and the nitrogen derived from nitre cannot be explained by the existence of argon in the air in the small proportion indicated by the actual extraction of the argon.

"Chemists, with much practical experience in original research, always attach importance to *the yield of the new substance;* and in cases where, as in the present instance, the yield of the new substance is only about one-twentieth of that which the theory requires, are inclined to regard the whole investigation with suspicion. The very existence of argon is at present in doubt, and will remain in doubt, until the extraordinary failure of yield has received satisfactory explanation."

Lightning, February 14th:—

"At last the ELECTRICAL REVIEW has decided on its line respecting 'Argon,' and no one can doubt the courage shown in taking it—as to wisdom or consistency that is another matter. A few weeks ago it was ready, on the strength of Lord Kelvin's testimonial, to accept the new gas, without any evidence that was satisfactory to its mind; now its former incredulity is intensified, despite an almost unprecedented chorus of assent from scientific men, whose 'absolute failure in the faculty of criticism' our contemporary remarks on as a curious episode. We then have an exhibition of the critical faculty as it should be used. The critical faculty ignores nine-tenths of the evidence offered, and fastens on one early experiment. Into this early experiment the critical faculty reads unauthorised figures of its own invention, and from these deduces a small and doubtful residuum of possible argon, and a moral against hasty inference."

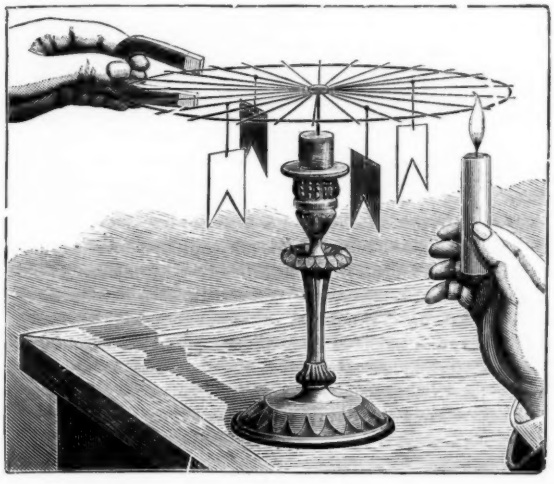
EXPERIMENT FOR THE DEMONSTRATION OF THERMO-ELECTRIC CURRENTS.

THE well known experiment, by means of which we show the currents that pass through a circuit formed of two metals when the junctions are at different temperatures, becomes more striking, when, instead of mounting a magnetised needle on a pivot placed in a fixed circuit, the circuit is, on the contrary, made movable, the magnetic field being in a fixed position. The idea of this reversal of the experiment is far from being new, since on this principle is based the radiometer invented by Dr. d'Arsonval, the construction of which has been greatly improved by Mr. C. V. Boys. This radiometer is a very delicate measuring instrument requiring in its construction scrupulous care and great manual dexterity; but the apparatus that we are about to describe works perfectly as a demonstrating apparatus, without requiring such care in its construction.

This instrument consists of a simple wheel, balanced on a needle, and set in motion by the thermo-electric currents under the action of a magnetic field. This wheel can be made with the greatest facility by bending into a circle a fine wire composed of an alloy of nickel and copper, known in commerce by the name of white bronze or superior German silver. This alloy has the property of giving, when united to copper, considerable thermo-electric electromotive forces; they are no doubt much weaker than those obtained from bismuth or antimony, but the alloy of which we are speaking has, besides the advantage of possessing a high point of fusion, that of being capable of being drawn out into fine wire, a condition essential to the good working of the apparatus, the junctions of which should become heated and cooled instantaneously. The rim of the wheel having been closed by a junction, we fix to it a certain number of diameters of very fine copper wire insulated from one another and joined after being wound at their extremity round some German silver wire. One of these diameters will support at its centre a little plate of metal in which a slight depression has been made. The wheel being adjusted by means of this plate on a needle, it will be regulated by the help of the little flags hung to some of the spokes (see figure), and which, by lowering its centre of gravity, enables

it to be displaced at will, and the wheel to be rendered horizontal.

Suppose now that we heat one of the junctions by means of a candle, a difference of potential is established between the opposite junctions, and an electric current passing through the diameter ending at the junction will return by diverging at the rim. If we apply a horse-shoe magnet in such a manner that it embraces a portion of the diameter in the half opposite the hot junction, the magnetic field will act upon the radius perpendicularly to its direction. As, moreover, the action on the rim is exercised in the direction of the radius, it would be *nil* even if the divergence were unequal, and the wheel will begin to turn under the action of the couple produced



The rotation, which is slow when we employ wire at all thick, becomes on the contrary very rapid with fine wire, which will consequently be chosen in preference, in order to render the experiment as striking as possible. Wire of one to two-tenths of a millimetre is well suited to a wheel from 8 to 10 centimetres in diameter. This transformation of calorific energy into electrical energy and mechanical energy is, it seems to me, the simplest that can be conceived.—Ch. Ed. Guillaume (*La Nature*).

REVIEWS.

Electric Transmission of Energy. A practical handbook, by Gisbert Kapp, M.I.C.E. London: Whittaker & Co., 1894.

The fourth edition of Mr. Kapp's book on the "Electric Transmission of Energy," comes none too soon. As the author says in his preface, since the third edition was published nearly four years ago, an enormous development has taken place in every branch of electric power transmission. The use of electricity for transmitting energy over long distances, as proved by the works at Lauffen, Rome, and Genoa, has become an accomplished fact, while the grandest scheme of transmission yet suggested is in course of realisation at Niagara. The several editions of Mr. Kapp's book may indeed be regarded as indices of the progress made, and so rapid have been the strides recently that the present volume, though revised and mostly rewritten, is of a size quite inadequate for justice to be done to so vast a subject.

The author introduces his work in some twenty pages, partly discursive, partly statistical. He shows the limits to the application of electric transmission of energy in the stored form, and discusses the advisability of replacing in factories the shafting and belting by electric motors driving each machine, or group of machines. It is pointed out that, as regards the application of electricity to coal mining it is not only on account of its greater efficiency as compared with transmission by compressed air, but also by reason of its greater convenience, flexibility, and smaller capital outlay for plant that the electrical methods find such ready adoption. The electric propulsion of vehicles is also touched upon in this section, and the overhead trolley wire comes in for the usual remark as regards unsightliness. The recent development of electric railways above ground and the projected railways underground are referred to as indicating the promise of progress which the immediate future holds.

By way of statistics the author shows that in the utilisation of the water-power at present running to waste there are plenty of problems in power transmission awaiting practical solution. The falls of the Rhine at Schaffhausen represent about 1,750,000 horse-power, while the total water-power in France is 17,000,000 horse-power. Comparing this with the steam power of our own country, Mr. Kapp calculates that the total horse-power developed in the United Kingdom during working hours is at the rate of 3½ millions, the annual coal consumption for steam raising being 30,000,000 tons. Though as far as power is concerned, the world taken as a whole could do very well without coal, individual countries could not, and, as might have been expected, electric power transmission has been developed most in countries where fuel is costly and waterfalls abound, such as South Germany, Switzerland, Italy, and the United States. In Great Britain, with cheap coal and very few waterfalls of any dynamic magnitude, the scope for large transmission plants is necessarily limited.

After his introduction, the author leads off, as formerly, with a chapter on general principles, in which is discussed the co-relation between mechanical and electrical units. Part of this chapter is devoted to an exposition of Hughes's theory of magnetism, and, so far as we can see, it is not until we reach Chapter IV. that we come upon new matter. In the earlier chapters we have still the illustrations of Barlow's wheel and the impracticable dynamo of Forbes. What connection this latter can possibly have with power transmission we are at a loss to determine; nor, for that matter, can we see what practical object is to be served by repeating in this fourth edition, the antiquated tests of the Griscom motors published in the first edition. These were all very well in the year 1886, when the phenomena which they exhibit was ill-understood, but we regard their publication in the present work as wholly out of date; if we are to have demonstrations from practice, let us use for them practical machines and not ancient toys. The descriptions of the Siemens and Gramme windings of armatures, pp. 81 to 85, are scarcely in the modern version, and fig. 24 is worthy of an antiquarian museum. Nothing short of rewriting the whole book from beginning to end could bring it thoroughly up to date after a lapse of eight years. The statement that the efficiency of conversion in medium sized and large motors should not be less than 90 per cent. is surely at this date historical.

In Chapter IV. are discussed the different types of field magnets employed in dynamos, and expressions are given by which can be deduced the ampère-turns required to produce a given field strength. Here we note real progress, for Mr. Kapp has abandoned the tangent formulæ given in previous editions in favour of employing actual magnetisation curves. The utility of this section is seriously marred, however, by the tenacity with which the author clings to what he has called "English lines." Surely it is time that this fad were given up. To men accustomed to think and calculate in C.G.S. units it is most irritating to have to follow the solution of a problem during which they have to keep in mind a different set of unit values, and when their introduction offers no advantages to be set against the brain worry, it is certainly a pity to mar the book by their adoption.

We cannot say that Mr. Kapp's reasoning is clear on page 131. It is there stated that a ring armature taken out of its own two-pole field and put into a four-pole field, will give double the output. This is quite illusory. The ring will give the same output in each case, provided the same fraction of the circumference is covered by all the poles added together and that the induction in the air gap is the same, which in practice would be the case. The E.M.F. generated in one quarter of the winding in the four-pole field will not be equal to the E.M.F. generated in half the winding in the two-pole, but will be *one-half*, hence we have for the output with the armature in four parallels half the former E.M.F. and twice the current. To say (page 132) that by increasing the number of field poles *per se*, the output is increased, is in our opinion incorrect and apparently it is forgotten that the relation of diameter to length of armature differs with the number of poles. For two, four, and six

poles there is a different proportion which is the best. In this chapter the effect of armature reaction as necessitating a lead of the brushes is clearly described; there are also given curves showing the relation of current and difference of potential, the relation of power and speed, and the relation of speed and current in series motors. Though the author mentions that Ayrton and Perry were the first to suggest a design of motor in which advantage was to be taken of armature reaction to strengthen the field, he does not appear to mention the latest development of this idea due to Sayer.

In Chapters V. and VI. the author gives his attention to the various systems of transmission by direct currents, and includes in his considerations systems in which motors are fed by mains at a constant difference of potential, or by a constant current, and systems in which only a single motor is fed at a distance from a single generator. The condition to be aimed at in all cases is constant speed of the motor, and the author describes the methods, ancient and modern, which have been suggested for attaining it. Amongst the former undoubtedly come the description, three or four pages long, of a mechanical governor of Ayrton and Perry, which never existed in practical shape, a method of self-regulation for constant current which has never, to our knowledge, been tried, and an invention of the author for the same purpose, which could not work. All these were in the first edition, and the pruning knife might be used here with advantage. Coming to modern methods, the compound winding of motors is described, but Mr. Kapp does not state that by reason of the weakening of the field by armature reaction, a shunt motor may be made practically self-regulating without a series winding. This would throw the reasoning about the extra weight for the compound machine out a little, making it something less than stated. The method of obtaining a constant speed by series-wound generator and motor is well described. The condition is that the difference between the ordinate heights of the generator and motor characteristics shall be for all currents equal to the voltage spent in overcoming the resistance of the circuit.

But one of the author's objects is to draw the attention of English engineers to the transmission of power by alternating currents, and Chapters VII. to X. are devoted to this branch of the subject. It is pointed out that direct current machines giving a higher pressure than from 2,000 to 3,000 volts are somewhat difficult to construct, whilst under the trying conditions to which they are sometimes subjected in power transmission there is considerable risk in their working. Accordingly, as the distance over which the power is to be transmitted increases to an extent necessitating higher pressures, alternating currents must be resorted to, and single, double, and triple-phase working are all dealt with in the book under notice. We must confess at the outset that we do not see what use is served by comparing the output of alternators with direct current machines. Comparisons, odious on most occasions, are here distinctly misleading, for the very simple reason that a direct-current machine of the same output as an alternator would have neither the same total field, nor the same number of active conductors, nor the same weight of iron and copper, nor probably the same speed. Mr. Kapp does not always succeed in being practical, and comparisons and analogies are we fear amongst his weaknesses.

We are apt to get impatient with the author when he discourses on impracticable methods of measurement for 10 pages or so, but the table on p. 242 giving the percentage error in measurement for various angles of lag in alternators may be held to atone for this fault. We agree with the statement that for alternators for transmission of power it is highly desirable to employ a method of construction which, on the armature being accidentally short-circuited, will not permit a current to flow too great to damage the machine. As the author says: The design must be a compromise, as a considerable amount of voltage drop while safe-guarding the alternator on the one hand, brings about a lowering of the power factor on the other hand, in itself very undesirable. It would seem that a machine with a 7½ per cent. drop from no load to full load, and which would give on short-circuit a current equal to five times its normal, is a very fair compromise, both for transmission and lighting, as a current of such magnitude would not hurt the machine for a short time, while the drop is not sufficiently large to introduce difficulties in the regulation. *Apropos* of current on short circuit, this will reach in a machine with a 4 per cent. drop something like 25 times the normal, enough to damage the machine permanently in a very short time. In comparing two machines of different frequency (page 253), it must not be forgotten that the particular business of a designer who knows his work is to suit his design to the frequency, and in order to secure the same drop in the machine of lower frequency, the obvious thing is to take copper off the armature and put it on the field. But it is impossible for any author to decide what is best in all cases, as each problem must be solved on its merits. Another thing which the practical designer has to keep before him is that for every shilling saved in labour he can spend eighteen pence in extra material and come out no worse at the end of the work as regards prime cost. The remainder of Chapter VIII. is devoted to the consideration of transmission by mono-phase current to a synchronous motor; and the effect of altering the strength of motor field, the break-out-of-step limit, the overload limit, and effect of capacity in the line are fully discussed.

The construction of polyphased current motors is dealt with in Chapter IX. Starting with an elementary form of motor, the author represents the distribution of the lines of force at regular intervals of the field rotation, and explains how currents are induced in the motor conductors, which following up the rotating field, thus produce the motion of the armature. It might probably have been of advantage if the resultant pull at various stages had been shown in tabular form, but this the author does not seem to think necessary. The effect on the field of the currents through the conductors, is next considered, the author assuming for the purpose of simplicity that the distribution of field is quite regular and may be represented by a sine curve. It is certain that the field cannot be correctly represented by a curve made up of broken straight lines, as shown at page 299, but it by no means follows that it is a true curve of sines, as the author is careful to state, though this forms a very good working hypothesis. The corners of the curve must be rounded off, due to the natural distribution of the lines in the air space; further, any variation of field strength is partially neutralised by the currents in the armature conductors, the practical result being that a two-phase motor works as well as a three-phase, though, according to the current curves, its variation of field strength is 41 per cent., that in the three-phase being only 16 per cent. The theory of the polyphase motor is most ably treated in a chapter deserving the most careful study, and it is only to be regretted that its thorough mastery will not enable one right off to design either a two-phase or a three-phase motor which will work decently. The theory of the mono-phase non-synchronous motor has Chapter X. devoted to its treatment. It appears from the tables of practical tests that three-phase motors of from 50 to 60 horse-power have an efficiency at full load of something over 90 per cent., with a power factor of ·84, while 15 horse-power mono-phase motors have at full load an efficiency of 88 per cent., with a power factor of ·93.

We do not think that Mr. Kapp's attempt to clear away the mists which ordinarily gather about Thomson's law for the size of conductors, results in making matters much clearer, but some curves are given (pp. 379, 381) showing the weight of copper required for transmission over different distances and at different voltages which should prove useful. We cannot see the use of making direct current transmission the basis of comparison as regards weight of copper for long distances, as it serves no good purpose to compare a scheme ruled out of possibility with schemes which may be applicable. Again, we do not admit that the condition which Mr. Kapp thinks ought to be fulfilled with reference to the insulation of the line is either fair or reasonable. It is difficult to see why di-phase transmission with three wires replacing four should necessitate our increasing the copper, seeing that the distance between the conductors on the cross-arms having the same potential difference between them (the large one being in the middle) is increased by 50 per cent. when three wires are used; and though the difference of potential between the outside wires is 40 per cent. greater, the distance between these is 150 per cent. of the original distance between the conductors when four wires were used. If it is argued that the length of cross arm between the conductors counts for nothing, then let us alter the insulator at

an almost negligible cost, but don't let us put 50 per cent. more copper into the line without due consideration. If the conductors used for the di-phase transmission are triple concentric underground with the large wire as the intermediate conductor, the insulation is strained to no greater degree than when two concentric wires are used, and we are therefore justified in altering the figure of 29 tons, which Mr. Kapp gives, to 17 tons as being more in accordance with what might actually be used on the work. With regard to three-phase transmission, this requires 15 tons of copper if the potential difference between adjacent wires be the same as in the two-phase transmission with three wires, so that the difference between the two systems is but slight, while the simplicity of working is enormously in favour of di-phase transmission. With the insulation of the generator itself there is no difficulty, and there is every reason to believe that in the future, di-phase with three wires will, to a large extent, supplant tri-phase working.

The last chapter, giving examples of generators and motors, is rather feeble, but this opens up the wider question as to whom exactly Mr. Kapp's book is written for. There is something in it of the principles upon which generators and motors are constructed, a good many theoretical investigations of the actions and reactions taking place in their working, something of measurement, a description of line materials, and a few examples of machines. But this work, when thoroughly mastered, will not teach one how to build a generator, or how to construct a motor, or how to arrange matters that the successful working of a transmission scheme is ensured. Though a splendid book for the lecture room, it is not really a work on electric transmission of energy at all, but a handbook which treats of some of the apparatus employed in power transmission. The engineer who has a power scheme under consideration wants to know above all what has been done hitherto, how the best transmission plants have been put up, what regulation has been found to work most successfully, &c., &c. On these points Mr. Kapp's book is silent, and it will scarcely be believed that there is not one single example given of a complete scheme. Notwithstanding this the work, as giving a comprehensive theory of the working of polyphase and monophase motors, is of considerable value, and it should find a place on the bookshelves of all engineers who take an interest in electric power transmission.

Electric Light and Power. By Arthur F. Guy. London: Biggs & Co.

Mr. Guy states in his preface that he hopes this book will be placed amongst those, having electricity for their subject, which are practical, as he has endeavoured to record and explain only what may be termed useful practical knowledge. While keeping this end in view, he appreciates the fact that some acquaintance with theory is requisite to enable the reader to grasp the laws which govern the action of apparatus, and therefore principles have not been ignored.

On a careful perusal of the book we are inclined to admit that this by no means low standard the author set himself, has been lived up to. Much of the matter is new in the form in which it is presented, while care has been taken in such parts as compilation has been resorted to to sift the useful from the useless, and the proven fact from the accepted hypothesis. In the 346 pages comprised in the book, Mr. Guy has attempted to cover a very wide field. This is no less than the history and present position of the heavy electrical engineering industry. In the second chapter the reader is taken to the coal store of an electric generating plant, and thence to the dynamo room, out along the circuits, to the consumer, and even traction systems. As a result, some previous acquaintance with the principles of electrical science is requisite to follow many of the arguments, and much of the reasoning, but given this, the book forms a comprehensive introduction to electrical engineering work, and gives a glimpse of the practical details which are met with after leaving college, and on going out into the world of business.

We have mentioned this because there is little in the book to recommend it to the general reader. In many respects the information is too precise, and requires an exercise of the mental faculties which cannot be expected from a member of the general public whose curiosity has tempted him to purchase, and perchance read, a work entitled "Popular Electric Lighting," or "Electricity Up-to-Date." There are signs, however, that Mr. Guy would allow his pen to run away if not carefully kept in subjection; this, for example, on page 14: "It may, in truth, be stated that the latter half of the nineteenth century will be famous as the 'Electric Age,' and will mark the development and application of a new and mysterious force, which has been tamed and harnessed through the indomitable energy of man to a thousand and one uses, benefiting all humanity—a force which does its work silently and swiftly, yet giving no signs of its presence," and so on. In the first place, electricity is not a force. Again, how can a force be tamed and harnessed? Lastly, Mr. Guy must have forgotten the many "signs of its presence" which electrical energy has given the public during the past few years, some of the "signs" having led to the intervention of the Board of Trade. The book opens with the mention of Davy's experiments, and briefly reviews the progress made during the present century in lighting and traction, showing the reasons why electric lighting has advanced so rapidly in the favour of the public. In the comparison of cost for gas and electricity, the figures given are hardly to be passed without comment, although the errors, being in reverse directions, cancel out. The data on page 29 requires careful revision, but it is shown that, lamp-hours for lamp-hours, electric lighting is twice as expensive as gas lighting. This is exactly the ratio which we know correctly represents facts, and Mr. Guy wisely introduces the "economics" of electric lighting in after pages.

The second chapter deals with motive power, or prime movers, and gives numerous tables which will be of use to those who cannot go to the sources of information from which such figures are derived. The simple facts connected with output, and cost of steam and gas plant, are put very clearly, and are to be commended. If anything, the chapter dealing with the laws of electricity and magnetism is that most open to criticism in the whole book. Mr. Guy is evidently at home when dealing with facts, his interpretation of scientific deductions leaves something to be desired. On page 114, Ohm's law is given in that erroneous, but persistent manner, which seems to be rooted in the practical mind, despite the best attempts of Profs. Ayrton and Thompson to put right. Finally, however, Mr. Guy gives "the above" as Ohm's law, the statement "above" being the proper expression, and one with which he might have opened his explanation. The treatment of the magnetic circuit is satisfactory, and this must be a fact of importance, as the discussion of dynamo construction which follows is based upon the more purely theoretical matter in the third chapter. The remainder of the work is given up to the practical applications of electrical energy, and here the author is at his best. Many useful hints are given regarding dynamo-room routine, and those details upon which experience is the best guide. Lighting by arc and incandescent lamps is gone into very fully, and the facts and data are arranged in order, so that an intelligent grasp of this section of work can be obtained from this book alone. The peculiar treatment required to successfully handle alternating current problems is attacked boldly, and what is said may serve to clear the path for a more complete examination when the reader proceeds to devote special attention to the mathematics of harmonic variation.

Although we have not mentioned page by page the observations which were jotted down at time of perusal, enough has been said to express our belief that Mr. Guy has written a book of value, and, especially considering the low price at which it is issued, one which can be recommended for private study to a student whose practical acquaintance with electrical engineering is a negligible quantity.

Personal.—*La Prensa*, of Buenos Ayres, states that the Senate of the University of that city has conferred, *honoris causâ*, the degree of Doctor in Science, Physics and Mathematics, on Don Manuel B. Bahia, the Argentine engineer, who at present occupies the principal technical position in the Government Telegraphs of that Republic, with the title of Inspector-General. The students of the Argentine National College and the faculty of engineering are much pleased at this distinction conferred on their teacher and colleague.

ARGON: THE SUPPOSED NEW ELEMENT IN THE ATMOSPHERE.

II.

Writing, with the newspaper reports of the recent meeting of the Royal Society before us, we remarked that the faculty of criticism seemed to have failed in an extraordinary manner on that memorable occasion.

We have now before us the paper published by *Nature*, which gives the scientific details, and which is unquestionably authentic, and we are bound to say that that impression is deepened.

The investigation consists of two distinct parts, viz., a repetition of the celebrated Cavendish experiment by Lord Rayleigh, and a set of operations in which Prof. Ramsay employed magnesium to absorb the nitrogen of the atmosphere.

Beginning with Lord Rayleigh's branch of the investigation, we note that Lord Rayleigh claims to have shown that the small bubble of gas, which remained at the conclusion of the Cavendish experiment, was argon, and not the inevitable trace of nitrogen (and possibly other gases) which, from the time of Cavendish down to the present day, it has been universally taken to be.

In support of his view there is his experiment in which 7,925 c.c. of air was gradually introduced into an inverted flask standing in a large glass beaker serving as a pneumatic trough. Along with that volume of air he introduced gradually 9,137 c.c. of oxygen and at the same time during a period of seven days a powerful electric discharge was kept up so as to diminisb the volume of the gas, and thereby permit of the entrance of so much as 17 litres of mixed air and oxygen into a flask which would apparently hold about one litre.

On the eighth and ninth days of this experiment we are informed that only oxygen was added to the gaseous contents of the inverted flask and that the volume of oxygen added in that manner was about 500 c.c., and that at the end of the ninth day there remained 700 c.c. of gaseous contents in the flask.

This residue of 700 c.c. was then treated alternately with oxygen and hydrogen and the electric discharge from the powerful electric apparatus, and it dwindled down to 65 c.c., and refused to dwindle further.

Now, let us ask how far this is a carrying out of the Cavendish experiment.

The first point which strikes a chemist is that whilst Cavendish operated on air confined by an alkaline liquid, there is reason for suspecting that at the end of his experiment, when the 65 c.c. refused to dwindle, Lord Rayleigh had his liquid acid. Reading his paper, we learn that the alkaline liquid was weak—how weak, he does not say—and we know that the 17½ litres of oxygen and nitrogen combined would give about 20 grammes of acid. The question which a chemist asks is, Where is the assurance that the weak alkali would not be used up by this acid?

Another vital difference between the Cavendish and the Rayleigh experiments is that the ratio of total gas to liquid is very different in the two cases. There is good reason for concluding that in both experiments a fraction of the nitrogen was burnt up only as far as nitrous oxide. Indeed, that conclusion can hardly be resisted by a chemist who takes count of the known properties of oxygen and nitrogen in chemical relation with one another. The bearing on the Rayleigh experiment is that the probability of the existence of some nitrous oxide in the residual 65 c.c. of so-called argon has to be faced.

Lord Rayleigh appeals to spectrum analysis, in order to settle the question as to whether the 65 c.c. is argon, or whether it is a mixture of commoner gases.

There is a way of dealing with the 65 c.c. by well known methods of gas analysis, but apparently that method has not been resorted to.

In the paper in *Nature* the fact is recorded—almost boastfully—that Lord Rayleigh's sparking arrangements enable him to oxidise nitrogen gas *three thousand times* as fast as Cavendish was able to do. In one hour 3,000 c.c. of mixed oxygen and nitrogen was rendered soluble in the liquid of the trough, whilst Cavendish could not convert more than 1 c.c. in one hour. Such being the resources at the disposal of Lord Rayleigh, we are lost in amazement when we gather from his paper that the total quantity of so-called argon obtained by the Rayleigh-Cavendish process does not much exceed 400 c.c.

The failure of the Ramsay process to furnish *the yield* has been dealt with on a former occasion.

FIRE AT THE KENSINGTON COURT ELECTRIC LIGHTING STATION.

At 9.45 on Tuesday night, the 12th inst., as we briefly intimated in last week's issue, a fire broke out in the offices on the first floor of the Kensington Court Station of this company. The foreman, John Holland, and his family, *i.e.*, his wife and three children, lived in the rooms immediately above the offices, and we regret to say that owing to the suffocating nature of the smoke which filled these rooms within a few minutes of the breaking out of the fire, one of the children was found to be dead when taken out by the firemen. The fire commenced at 9.50, that is to say, it was then first noticed by the working shift in the engine room below. The alarm was given, and fire engines arrived in seven minutes; the smoke forced the working shift to leave the station before 10 o'clock. At this time the fire had reached the fuse boxes of the lighting system, putting out the lights in the engine room: this, and the dense smoke, forced the men to shut down the engines, and they were unable to get to the switchboard to switch on the extra cells, so that as there was a heavy load on the station, the pressure quickly fell to 90 volts. Mr. Crompton, who lives next door, reached the fire at 9.55, and at once attempted to get to the switchboard, but it was not until 10.5 that Mr. Crompton and Mr. Miller, who had then arrived, were able to do this, delay being caused by the thickness and suffocating nature of the smoke. They were able to switch on the extra cells, and bring the pressure back to 100 volts on each side of the three-wire system, and until the fire actually attacked the roof over the accumulators, the pressure was maintained. When this took place, the supports of one of the large conductors connecting the third wire with the centre point of the batteries became loosened, and allowed these weighty conductors to fall across a line of cells, and this made a heavy short circuit on the negative side of the system. This for some time lowered the pressure on that side of the three-wire network near to the station.

The salvage men did excellent work in the early stages of the fire, getting tarpaulins over several of the steam dynamos. As soon as the heavy short circuit on the negative side was observed, Mr. Miller, at great personal risk, went down into the subway through which the main conductors are led away from the station, and succeeded in disconnecting the system of conductors from the switchboard of the burning station; as soon as this could be done, full voltage was obtained from Knightsbridge end of the system, aided by the accumulator station at Queen's Gate Mews. The fire gradually spread over the whole of the accumulator room floor, so that everything above the level of the fireproof floor, which separates the accumulator room from the engine room, was practically destroyed. The great difficulties met with in dealing with the connections arose from the extinction of the light, the blinding nature of the smoke, and the splashing of acidulated water from the accumulators above on to the switchboard connections. The fireproof floor, above mentioned remained intact, and is still in good order, and owing to this the boilers and generating system suffered very little; in fact, if it had not been for the acid water splashing down through the apertures through which the conductors are led from the accumulators to the switchboard, the engines could have been worked continuously throughout the fire, or, at any

rate, from the time that the first dense smoke had been dispersed, and the short circuits removed. As it was, the firemen could not be induced to cease pumping into the accumulator room until long after all traces of fire had disappeared. As soon as they left off, two engines were started and connections made, so that these could be used to charge up the Queen's Gate Mews accumulator station. From that time up to the present the supply has been maintained with the same regularity as heretofore, although the day load of Wednesday was an exceptional one, owing to fog.

As above stated, the damage is confined to the building above the fireproof floor, and the accumulators (which have been in use more than six years, and were in excellent order) are practically destroyed. All the massive copper connections are so twisted, that they will have to be remade. At the evidence given before Mr. Troutbeck, the coroner for Westminster, it was proved to the satisfaction of that gentleman that the lighting of the engine room was not stopped until long after the fire had been burning fiercely, and that even now a great portion of the wiring and fuse boxes are intact. This is fair proof that the fire was not due to electrical causes, as with the sole exception of the lighting arrangements of the station and offices, all electrical connections are confined to the switchboard side of the station, which is still unburnt. There is direct evidence to show that the fire commenced in a corner of the accumulator room, where some spare drums of cable were stored, and that these drums of cable took fire almost immediately, and that the smoke from them, added to the smoke of the burning woodwork, was the cause of the child being suffocated. It is difficult to understand how these cables could have become ignited unless something of a more inflammable nature had become ignited first, so that it seems probable that some oily waste had been thrown down into this corner, which is a comparatively dark one, and had become spontaneously ignited, or had been ignited by a match thrown down by a workman. Of course, everyone denies the possibility of this, but it seems the only solution of the problem. The orders in the station are most strict in respect of oily waste, which has to be taken to the furnaces and burnt immediately after being used.

As regards the points to be noticed from this first great fire which has taken place in an electric generating station in England, Mr. Crompton states that there was no difficulty in handling the connections at the full pressure of 200 volts, although owing to the splashing of acid on to the clothes and hands, and to the heavy "earth," caused as previously described, the shocks were felt more severely than would be the case under ordinary circumstances. A large number of connections were made and re-made by the staff without their experiencing more than temporary inconvenience. The lowering of pressure on the negative side lasted for nearly three hours, but on the positive side the pressure was never below 87 volts. The extraordinary nature of the frost caused great delay in getting up certain of the covers of the road boxes in which it was necessary to alter some connections; two of these took 2½ hours to thaw them; if it had not been for this, the pressure on the negative side would have been brought up to normal within five minutes of the fire. Mr. Crompton tells us that he is extremely proud of the coolness, pluck and nerve, shown by Mr. Miller and the rest of the staff; no mistakes were made, all orders were carried out promptly, and with the exception of the unfortunate loss of life, the company will suffer very slightly, if at all, from the occurrence, as the station is fully insured, and the loss due to interruption of supply is very trifling. The total damage from material destroyed will not exceed £7,000. This result is greatly due to the substantial character of the building, to the satisfactory behaviour of the fireproof floor, and to the good working of the ventilating arrangements of the engine room, which cleared it comparatively rapidly of smoke, and allowed the staff to enter it to work the connections. Although the firemen were at first much alarmed at the possibility of electrical shocks, they were soon reassured, and practically none of them suffered in any way. An iron tank of liquid fuel (astatki), which was fixed over the top of one of the boilers, bore the brunt of the fiercest part of the fire, and did not ignite, as it was well covered, showing that with proper precautions liquid fuel of this class is more easy to protect from fire than the ordinary coal in the bunkers.

BÉNIER'S GASOGENE ENGINE.

This patent of Bénier's, described in *L'Energie Electrique*, draws its gas directly from the gasogene without intervention of holder or scrubber, and gives an explosion each revolution by virtue of having a separate compression cylinder, the crank of which is placed 90° from the working crank. With a nominal power of 15 H.P. at 150 revolutions, the cylinder has a diameter of 300 mm. and a stroke of 439 mm., the air pump being of 400 mm. diameter, and the gas pump 290 mm., the stroke of each being 209 mm. The gasogene was equal to 25 H.P., an excess not favourable for economy, but convenient in this case, as it enabled comparative tests to be made by the author, M. Aimè Witz, both with anthracite and coke. The whole space occupied by motor, producer, and all accessories, was only 5·20 m. by 1·60 m., and but two metres in height. A Prony brake was used, and a revolution counter and an indicator carefully calibrated. Diagrams were measured by planimeter.

The anthracite used was English, a coal of good quality, riddled, and of 8,000 calories, the coke used in the other test having a capacity of 6,800 calories per kg., and it came from the Paris Gas Company, and contained 10 per cent. ash and 6½ per cent. water. The price of the two fuels was assumed as 35 and 28 francs per ton. Samples of gas were taken for calorific determination by radiometer, and the water used was gauged, and its temperature taken before and after use, also the exhaust temperature of the engine by Salleron's calorimeter.

With anthracite on a 12 hours' run at 150·79 mean speed, and a brake horse-power of 14·59 (French H.P.), the mean pressure on the diagram was 2·65 k. per cm^2., and the indicated horse-power was 27·60, compression was to 4·54 k. The pressure of explosion reached 7·26, and the mechanical efficiency 0·53. For this there was consumed a net weight of 125 kilos of fuel, or 115 kilos after deducting 10 kilos for ash. The total water used was 4·032 m^3. in the gas washer, and 6·048 for the jacket, and the consumption of fuel per net H.P. hour ·714 k., equal to ·657 of pure carbon, the water consumption per effective H.P. hour being 57 litres. The following temperatures were noted of the gasogene externally, 177° C.; of the washer, 40°; the gas charge, 20°; of the cylinder, 69°; of the exhaust, 300°; and of the water before use, 11°.

The gas had a calorific power of 1,149 calories per metre cube (at 0° and 760 mm.), and contained 0·8 per cent. of CO_2 and 0·3 per cent. of oxygen. The thermal efficiency of the whole was 11·3 per cent. In the test with coke the mean speed was 147·18 revolutions, and the trial lasted 10 hours 25 minutes at a brake power of 14·7, the coke consumption being ·752 kilo. per effective H.P., or ·636 kilos. of pure carbon, the gas having a capacity of 1,035 calories, and containing 1·53 per cent. of CO_2, and 0·3 per cent. of oxygen.

The heat utilised was the same as in the anthracite test, namely, 635 calories, which corresponded with an efficiency of 12·4 per cent., coke apparently giving a better efficiency and utilising as much from a total heat of 5,113 as was utilised from 5,712 calories in the first test. Referred to price of fuel, each brake horse-power hour cost 2·45 centimes for anthracite and 2·10 centimes for coke. But as a fact the producer was about of correct size for coke and too big for anthracite. The peculiarity of the gasogene is that the engine draws the air through it, so that its duty follows the demands of the engine. The mechanical efficiency of the engine is thus made very low, however, and it would be interesting to have the gas and air pumps indicated. The working of a producer by aspiration renders all escape of gas impossible, and so abolishes danger of suffocation of attendents or others, and M. Witz is favourably impressed with this producer, which marks a step in industrial progress, and a special advance in gas engine practice.

RULES OF THE ROAD AT SEA.

The Board of Trade, in a document published a few days ago, give the following rules which are to be followed by vessels laying telegraph cables:—

(*h*) Vessel laying a telegraph cable.

At present such a vessel is compelled to carry special lights, but during fog she is obliged to sound the same signal as an ordinary vessel under way. This is unsatisfactory. A vessel laying a telegraph cable is necessarily unable to manœuvre with freedom, and therefore she should be both allowed and compelled to indicate in some manner the special danger she presents.

As to the signals allotted to these cases:—

By the present Regulations at Sea, putting on one side the red and green bow lights, a single light or a single sound is an indication of danger and a signal demanding cautious navigation.

Any number of additional lights, while giving no additional right of way, indicate additional danger, and therefore additional need of caution. Practically, this rule is all that is necessary for the ordinary mariner to remember. Precisely the same rule is proposed for fog signals; as the number of sounds increase greater caution is not only necessary, but compulsory. While in each case greater care is imposed on the vessel best able to manœuvre, in no case are greater rights conferred.

Although arranged by long and short sounds for additional communication purposes, each signal was specially chosen as depending, as far as danger and caution goes, not so much on the character of the sounds, but on their number.

Taking the case of steam vessels.

A single prolonged sound on the steam whistle during fog is the well-known indication that a moving steam vessel is near.

A signal of two prolonged sounds on the steam whistle was chosen to indicate the increased danger presented by a steam vessel under way but stopped; such a signal compels increased caution on other approaching vessels.

On so approaching nearer, if a bell is heard (the present anchor signal) it indicates that the vessel is at anchor and in an unusual anchorage ground.

A signal of two sounds on the foghorn coupled with ringing the bell to indicate a sailing vessel at anchor in a fairway at sea was chosen as being as similar in character as possible to the steamers' signal under the same circumstances. As practically the foghorns now in use are seldom heard further than the bell, it is not likely to be mistaken for the signal of a sailing vessel on the port tack. For years the fishing fleet have used a single blast on the foghorn, coupled with ringing the bell to denote they were attached to their nets without mistake arising from the signal being confused with that of a vessel on the starboard tack.

A signal of three sounds on the steam-whistle indicates the additional danger presented by either a vessel towing, a vessel laying a telegraph cable, or a vessel that may be passed with extreme care. It is practically immaterial to an approaching vessel, on hearing this demand for special caution on her part, to know which of these dangers—neither of which can he safely pass close to or close astern of—is near him. But means are afforded by the proposed characteristic of the signals for him to ascertain, if he wishes to do so.

A signal of four sounds on the steam-whistle indicates the greatest danger of all—presented by a vessel unable to get out of the way of another. It asks for the right of way and demands excessive caution on all hearing it. The reason for adopting short sounds instead of long ones was on account of the unnecessary excessive noise inconveniencing the maker of the signal.

THE SELECTION OF MOTIVE POWER.

This subject is treated of by Dr. Chas. E. Emery in the *Engineering Magazine*, but in this, the first paper, he does not get far into his subject and we learn very little about the selection of motive power. We are practically limited to two primary sources of power so far as this world is concerned, namely, the heat of the sun as applied at the present time in raising water from the sea to fall in rain and be a source of motive power, or to cause motion in the atmosphere to turn windmills, and the prehistoric heat of the sun which was stored in coal, a mineral which consists of carbon separated by solar heat from the atmosphere and thus raised to a higher position, from which it falls to a lower by oxidation with evolution of heat. Mineral fuel thus forms the most reliable source of power for continuous working at given hours. Next comes water when stored in large volumes. Indeed, given the wheels in which to use it, water appears to us the most reliable of all powers when it comes from a large reservoir, for it can be instantaneously used to the full capacity of the motor, and such is by no means the case with steam. The universality of steam power has made it the standard with which others are compared. Electricity is not a motive power but may become so in the same degree as steam, should means be forthcoming to generate it directly from the combustion of fuel. At present, however, it has only the characteristics of compressed air or water, ropes, belts or shafting. Wind power is by no means small in amount and has been invaluable in the drainage of Holland, but owing to its uncertainty it is ill-fitted for work involving the employment of labour. Wind power can be used, as it was by Mr. Brush, to charge storage batteries with electricity, and can thus be made to afford light or power for continuous periods. Messrs. Carwardine, of the City Road, indeed, did try the system but it did not please the County Council and had to be abandoned.

The steam engine is not the only heat engine. For small powers the hot air engine is available. It is safe and non-explosive, but we recently had occasion to secure prices of hot air engines, and it occurs to us that their cost is out of all proportion to their power. We would name the Davey motor as an example of a safe motor of greater power than the air engine, and of less cost, while with a hopper boiler it will run for hours without attention.

Dr. Emery would bed gas or petroleum engines on soft earth or sand, and free from contact with the walls of a building, or rock foundation if vibration is to be kept out of the buildings. Dr. Emery also refers to the use of producer gas in gas engines as having been common in England for years, and now used in plants of 25 to 400 horse-power. It would appear from this that there are no producer plants in America, except it be in steel works, for purely furnace work.

He compares the gas engine with the steam engine, in that the heat undergoes an equal number of transformations and processes, and states that in the gas plant part of the heat is devoted to making gas. He is wrong here. In either the steam boiler or the gas producer there is the same absorption of heat in converting the fuel into gas. True, it is thrown away in the gas plant at the coolers, scrubbers, and in the holder, but no heat is employed to produce the gas that is not also so employed in the steam boiler. Burned to monoxide, carbon generates 4,400 units of heat; burned to dioxide, it generates 14,500 units; the difference, 10,100 units, is rendered latent in the process of gasefying the carbon, which is equally the case in the steam boiler furnace. But none of the 4,400 units goes to produce the gas, for if it did it would not be there to be measured. After cooling there will be produced, by the combustion of so much carbon monoxide as contains one pound of carbon, 10,100 units. This is the heat available for use in the gas engine using producer gas, and may be compared with the 14,500 units available from a pound of carbon burned in a steam boiler. Of this amount there will rarely be more than 10,000 units utilised in steam production, and thus the gas and steam engine are very much on all fours in the amount of heat that enters their cylinders from each pound of fuel burned. In the gas engine an enormous amount goes to waste in the water jacket. In the steam engine a still larger amount goes to waste in the shape of latent heat in the exhaust steam and in cylinder condensation, which is a device of the cylinder metal for effecting a most unfortunate transformation of heat from and to the working fluid. In the end the gas engine comes out best, partly because its working fluid is not all steam and cannot be condensed. Dr. Emery fears the irregular action of gas producers and consequent unequal quality of gas. We think he need not fear this. We were told a few days ago by the attendant upon a gas producer of duplex type that the holder had been practically stationary all day, the engine running all the time and the producer having been regulated to keep the supply identical with the demand so that the holder could have been put out of circuit. Dr. Emery closes his first paper with a few remarks on steam engines, not of special interest or novelty, but rather of semi-historical nature. Dr. Emery is, we would almost say, prejudiced in favour of the steam engine with its perfect mechanism, and easy adjustment, and regulation. The low price of the steam engine is also in its favour as compared with the gas or petroleum engine, but in the near future this cheapness will equally characterise the newer motors as they become more common and large steam engine builders take up the manufacture. Then the steam engine will give place to the gas engine—a change that to a man brought up as a steam engineer will be anything but welcome. We can understand Dr. Emery's prejudice and sympathise with it, but even with this double entrenchment hard facts will make their way.

LEGAL.

The Cassel Gold Extracting Company *v.* The Cyanide Gold Recovery Syndicate.

The further hearing was continued on Thursday last week, when Sir R. Webster, continuing his opening, said he relied very much upon the evidence of Mr. MacArthur, the patentee, for establishing the state of knowledge amongst scientific men at the date of this patent, and this witness was a witness of strict truth and accuracy. He stated in his evidence that, so far from the results of the action of cyanide of potassium used for gold extracting purposes being obvious to him, he tried his experiment three times over to satisfy himself that he was not being misled. He experimented on three ores from different mines in different parts of the world. He found that in each of three ores extraction was commercially complete; and he had no knowledge that cyanide of potassium could be applied in the way in which he subsequently applied it. He also experimented with regard to the strength of the solution, and found that with a strength of 1 per cent. within a working margin, he got the best results. This weak solution of 1 per cent. had a selective action in the extraction of gold, and as the solution became stronger, the selective action became impaired. Referring to the Pielsticker process, Sir Richard said it was not fair to the patentee to say that his invention was not new because of the laboratory knowledge that cyanide of potassium had some solvent action. Infringement was not disputed by the defendants at the end of the plaintiffs' case; and after the evidence of Lord Kelvin and others, the plaintiffs offered at once, at the suggestion of the learned judge, to have further experiments made with the defendants' process. The only defence for a long time was the alleged anticipations. The defendants' process was brought out by Mr. Pielsticker, who came to England for that purpose, and published opinions that his process was not an infringement. Although the process was to some extent worked in secret, the plaintiffs managed to obtain some information about it. Mr. Pielsticker used practically the same strength of cyanide of potassium as the plaintiffs did to dissolve the gold. He then ran the liquid off from a tank into another tank, and in that other tank he redeposited the gold by electricity on iron, and then got the gold off. But in addition to this, Pielsticker's process sent an electric current through the bath, and this was supposed to be a distinction. This alleged differentia, if established, might have given a different aspect to the case. The defendants said, "It is quite a mistake to suppose that we are using cyanide of potassium in order to dissolve gold out of the ore. What we are doing is this: we have got an anode below, and a cathode at the top, and we are sending an electric current through the bath in which we put the crushed ore, which is then stirred about with a solution of cyanide of potassium. The result is that muddy water goes into this box [model produced in Court], and the liquid came into the tank, where it was deposited by electricity, and the gold was got off." The defendants' case came to this, that they were not operating by cyanide of potassium at all, but were carrying on an electrical separation, which was the development of an old patent by Rae. If this distinction had been made out, and had not been contradicted, it would have been a very substantial point of attack; but it had not, the learned counsel submitted, been made out. The defendants were working their process by cyanide of potassium, *plus* electricity, and Lord Kelvin and others who had made experiments, had in their evidence stated that in this process there could be no electrical action. It was shown that identically the same amount of action went on if cyanide of potassium were used with electricity or without it, so that the use of electricity did not alter the question of infringement. No one denied that gold could be got out of this solution by electricity; and all that the defendants were doing was to apply an old and well-known process of redepositing out of solution by the old process of chemical deposition as plates of metal put in the bath. The plaintiffs' patent was for obtaining a solution of gold from ore

by an improvement in the zinc method. With reference to anticipations, the learned counsel said, according to the most recent decisions of the House of Lords and the Courts of Appeal, the cardinal principle to be sought for in specifications alleged to be anticipations was, would a workman of ordinary intelligence find such directions as to enable them to work the process which it was sought to invalidate. Prof. Roberts-Austen, of the Royal Mint—a most competent authority on this subject—said in his evidence that the plaintiffs' discovery was a complete revelation to him. The learned counsel then put in and read the specifications relied on by the defendants as anticipations, and afterwards read with comments the evidence given in the Court below.

The Court again adjourned.

Friday (15th inst.) was the third day of the opening by Sir R. Webster, Q.C., before Lord Halsbury and Lords Justices Lindley and Smith, of the appeal by the plaintiff company against the decision of Mr. Justice Romer.

Sir R. Webster, Q.C., Mr. Fletcher Moulton, Q.C., and Mr. Waters appeared for the company; Sir E. Clarke, Q.C., Mr. Ralph Neville, Q.C., and Mr. Goodeve appeared for the syndicate and for Mr. Pielsticker, and Mr. Teed held a "watching" brief for the Gold Ore Treatment Company.

Sir R. WEBSTER, resuming his argument, said he desired to impress on the Court that the evidence clearly showed that the learned judge who tried the action had not paid sufficient regard to the decisions of the House of Lords in patent cases, in which it was held that where a mere laboratory knowledge, having practically no commercial value, had been turned by a patentee into a process of enormous commercial value, that patent could not be said to have been invalidated by anticipation or prior publication. The specifications of Rae and Simpson could not, he submitted, be successfully held to be anticipations, because they would not do what the plaintiffs' patent would do—the very thing which gave it its commercial value. The only evidence given with regard to Simpson's patent was one experiment whereby $\frac{1}{1000}$th part of a grain of gold was got from two small pieces of ore—a result obtained during the course of the trial, but not one of commercial value. The plaintiff company's specification was taken out in 1885, and since that date had been in general use in South African mines; and although the royalties paid to the plaintiff company amounted in the aggregate to an enormous sum per annum, no evidence had been adduced to show that Simpson's patent had been or could be used; on the contrary, there was evidence that, under the conditions described in the specification, it would be absolutely impossible to precipitate gold or zinc. It simply came to this, that Simpson's was an abandoned paper experiment. He had written down in his specification what he thought pointed to the fact that cyanide of potassium and carbonate of ammonia could be used commercially as a solvent; but there was no evidence that it had been so used commercially in any part of the world. Could it therefore be said, with the fact of the more recent decisions, that a useful discovery of great commercial value had been invalidated by a mere paper anticipation?

LORD HALSBURY: In respect to chemical patents, the exact directions given in specifications are most important, because a very small difference may determine whether the patent will work successfully or no.

Sir RICHARD WEBSTER: Yes; will make all the difference in the world. In this case the plaintiffs' patent will successfully treat 2 dwts. of gold to the ton.

LORD HALSBURY: And what is the value of 2 dwts?

Sir RICHARD WEBSTER: About 9s., and so small an amount can be dealt with according to the evidence, on account of the selective action of a weak solution of cyanide of potassium. It acts on the gold as distinct from the copper, iron and arsenic; but Simpson put gold in the same category as the baser metals. In Australia the attempt to use the cyanide process failed.

LORD HALSBURY: Is there any description of the average component parts of the Australian ore?

Sir R. WEBSTER: Yes: 1 per cent. of copper, 15 per cent. of iron, 20 to 25 per cent. of arsenic, 8 per cent. of lead, and about the same of zinc, 20 to 25 per cent. of sulphur, and about 2 to 3 ounces of gold per ton.

LORD HALSBURY: Supposing Australian ores are not capable of being dealt with by this process, how does your observation become relevant?

Sir R. WEBSTER: It is not my case that it is relevant, and it was argued in the Court below; but on this appeal an attempt has been made to raise an issue not before raised, in order to invalidate this patent on the ground of its want of utility. It is now said, "Oh, but your process failed to be of commercial value in Australia."

LORD HALSBURY: But what does that matter if your process has been found useful in extracting gold from the ore in South Africa?

Sir R. WEBSTER: It is my argument that it is useful when worked as it is intended to be worked. It works commercially in South Africa, and the South African mines pay us royalties.

Sir E. CLARKE (interrupting): Our submission is, that it does not rest on the question whether this patent was, or was not, successful in treating Australian or any other ores. The question is whether this cyanide process was used and known in Australia prior to the date of the plaintiffs' patent? If it was, then there is an end to the plaintiffs's claim to have his "invention" protected, and Mr. Justice Romer held that there had been such anticipation as invalidated his claim.

LORD HALSBURY: This is entirely a new view to me, and of course makes Sir Richard's observations and remarks relevant.

Sir E. CLARKE: In one of the answers by a witness as to the character of the ores at Johannesburg, it is stated that after the ore has been treated by the "amalgamation" process it is in a fine divided condition, and fit for the application of this process.

Sir R. WEBSTER (continuing) would not reply to remark of his learned friend at present, further than to say that from beginning to end of the case in the Court below no suggestion had been made that prior to the MacArthur-Forrest patent any process had been commercially applied or used in Australia. There were instances given of laboratory experiments in 1884-5.

Sir E. CLARKE: On the contrary, we say that the cyanide process was worked in Australia in 1884-5, and prior to the date of the plaintiffs' patent; but the ores were such that the process failed to be of commercial utility. The process is however applicable to South African ores; but there the process is the same, and that the Court below held to be fatal to the plaintiffs' claim.

The Court adjourned at one o'clock, and there was no sitting on Saturday.

Sir R. WEBSTER, Q.C., at the sitting of the Court on Monday, informed their Lordships that he had omitted to draw attention to the drawing showing the defendants' apparatus, and also showing the two currents of electricity.

LORD HALSBURY: I don't think that anything turns upon that. If what you say is right, the electric current is of no more use than a "jack-in-the-box."

Sir R. WEBSTER only thought it necessary to draw attention to the fact that he had omitted to draw attention to the drawing-in question. The learned counsel then proceeded to read the judgments of Sir George Jessel, Lord Esher, and Sir John Holker in the appeal of the Otto gas engine patent case, with the purpose of showing that, in the opinion of the Court of Appeal in that case, a clear distinction was drawn between a written document—a specification, for example—and a mechanical machine, when considering the question of anticipation. Taking this view of the case, then it was necessary to show that the specifications of Rae and Simpson contained such a description of the plaintiffs' process that any person conversant with the subject would have done what the plaintiffs had done.

LORD HALSBURY said he was of opinion in these patent cases to construe specifications according to the legitimate meaning of the language, and not to put on them anything in the shape of "benevolent interpretation."

Sir R. WEBSTER had not said anything which would cause the Court to infer that he had wished for "benevolent interpretation" in his favour. Taking Simpson's patent, no one pretended that it would work as described in the specification. Mr. Bowick himself, in the witness box, said that Simpson's process would not re-deposit, on account of the sludge or mud in the vessel. There had been laboratory experiments.

LORD HALSBURY: By whom?

Sir R. WEBSTER: By Mr. Harland, and he extracted about $\frac{1}{1000}$th part of a grain from a ton of ore. The argument against the plaintiffs was that any person dealing with Simpson's specification would, *à priori*, have come to the conclusion that carbonate of ammonia was not wanted; and further, *à priori*, he would have done something else. On the other hand the plaintiffs' specification described the process, which had been shown to be one of great utility. It stated that a solution described must be produced and then drawn off, and the gold recovered from that solution. It was said that if any person used Simpson's, he anticipated the plaintiffs' patent; but he (Sir Richard) contested that argument altogether. The short answer was that the defendants were not using Simpson's patent. Mr. Bowick himself showed that Simpson's was practically an abandoned experiment; but it was not necessary for him (the learned counsel) to take the burden of proving that on himself, because Simpson's was not an English patent—it had not been worked in England, it had only been published here. Unless it could be said that any person working Simpson's process would be led to do precisely what the plaintiffs had done, then according to the decided cases the plaintiffs' patent was perfectly good. The problem in 1884 was not merely dissolving gold in ore; if that was so, then any chemist or assayist of experience could have solved it; the problem was to recover the gold in the shape of metallic gold as it came away with the sludge or stuff, just in the same way as the silver plater obtained his silver from a solution. This problem was solved by the plaintiffs, who extracted, with good commercial results, 2 dwts. of gold, worth 9s., from a ton of ore. Rae thought that electricity was necessary, and Simpson thought something equivalent to electricity must be used; but McArthur did not employ electricity or its substitute, but first dissolved the gold, and then extracted it. In conclusion, the learned counsel submitted that the plaintiffs' patent was valid, and the defendants having been guilty of infringement, the plaintiff company was entitled to the relief asked for.

Mr. MOULTON followed on the same side. He said the sole question with regard to Simpson's specification was, was it practical, and would it work? The answer was that it was neither the one nor the other. Persons might have gone on experimenting with Simpson's process down to the present day, and without knowing why, because the gold was precipitated in the presence of the sludges. They must have failed, unless they did what McArthur did, because by Simpson, all the base metals were extracted, and the cyanide was killed. An economic selection was necessary, and that was obtained by using a weak solution, which first attacked the gold. The question was: "Who first enriched the world with this knowledge?" If Simpson had known what was necessary to make his process useful, he would have enriched the world; but he did not, and the profit and credit belonged to the plaintiffs.

Sir E. CLARKE, in support of the decision of the Court below, hoped to be able to convince their Lordships that this judgment was right both in law and fact. He was glad to hear their Lordships in their observations express the opinion that it would be necessary to construe the specifications without any "benevolent" feelings, but simply with regard to the ordinary meaning of the language employed. During the present arguments his learned friend had said

a great deal about the selective process of the plaintiffs' patent, but he (Sir E. Clarke) was under the impression that that part of the case was abandoned in the Court below.

Sir R. WEBSTER: No; it was never abandoned.

Sir E. CLARKE: Thought that it was towards the end of the plaintiffs' case, and he read from the shorthand notes a discussion which took place on that point between Sir R. Webster and the learned judge. If it was not abandoned, then it was necessary to see what the argument was worth. If worth anything, it would mean that a solution containing cyanogen of certain degrees of strength would attack ores of certain degrees of richness with certain results, and if this was the proposition then it was unfortunate for the plaintiffs' claim that MacArthur's patent did not give the degrees of strength which should be given to the solution in order to obtain these results. In one respect the utility of the plaintiffs' patent was not denied, for no one doubted now that the use of cyanide of potassium in extracting gold from a solution or tailings or finely powdered ore was very useful; but a great deal more was left to individual judgment and experience to decide what strength the cyanogen should be in order to obtain the desired result. The specification was imperfect in this respect. The kind of solution to be used as the solvent was described very vaguely and very broadly, and it might be said if the plaintiff succeeded that no one, so long as the patent was in existence, could use cyanide of potassium or any solution containing cyanogen, without infringing the plaintiffs' patent. The claim was for any solution containing cyanogen, or any cyanide soluble in water (such as cyanide of potassium), or any other substance or compound containing or yielding cyanogen. There was no application of machinery, or device, or scheme of any kind required. All that was needed was to pour the solution on the ore, stir it about or not and let the solution do its work. The patent was not to be tested by its practical, commercial, or industrial success, and yet it was on these grounds that the plaintiffs' claims were principally based. At the date of the plaintiffs' patent, in 1885, it was perfectly well known that a solution of cyanide of potassium would dissolve gold in a fine state, and that the finer the gold the more speedy the process; and in 1867 Rae took out his patent in the United States for the extraction of gold from powdered ore, and in 1884 Simpson took out his patent for the same purpose also in the United States, and as it was knowledge common to scientific men in 1885 that cyanide of potassium was a solvent of fine gold, there was not much invention on his part in applying such knowledge. The learned counsel then proceeded to read the evidence given at the trial, which showed that Prof. Faraday published in his works some of the results which weak solutions of cyanide of potassium had on finely-powdered gold.

At this stage the Court adjourned.

On Tuesday Sir E. CLARKE continued reading evidence in the Court below at the trial of the action with reference to the selective action of cyanide of potassium according to various degrees of strength. After referring to Professor Dewar's evidence the learned counsel said that plaintiffs originally set up a true selective action—very different from the action now set up—but after the evidence given by the witnesses in cross-examination that point was practically abandoned. Both Prof. Roberts-Austen and Lord Kelvin said they had tried no experiments, but they knew as a matter of abstract knowledge that the strength of a solution would affect its selective action, and a strong solution might dissolve in a different order to a solution of weaker strength.

LORD HALSBURY: That is consistent with the patent, is it not?

Sir E. CLARKE: If it means that it attacks the metals in a different order, that is so; but it is not the selective action contemplated. Prof. Crookes's answer in cross-examination on the same point was that a weak solution would attack gold and silver first. A strong solution would attack the iron and copper compounds and sulphides, and, therefore, prevent the attack on the gold. The learned counsel observed that taking that answer as correct, a strong solution would have a selective action the other way.

LORD HALSBURY: If I understand it, the evidence is that a strong solution would attack all the metals in the ore.

Sir E. CLARKE: And bring more of the iron into solution.

Sir R. WEBSTER: I agree there.

LORD HALSBURY: It would bring out the baser metals, the effect of which would prevent the gold being dissolved.

Sir E. CLARKE, continuing, said Prof. Crookes said a strong solution would not attack the gold simultaneously—the sulphide-iron surface would prevent the gold being so readily attacked. A dilute solution of ¼ per cent. (the weakest solution given by the plaintiffs' patent) would attack the gold. Commenting on this, the learned counsel observed that the weak solution would first attack the metal most sensitive, and that would not be a question of the order of selection, but of the degree of strength to be employed.

LORD HALSBURY: Suppose you are right, the effect is the same, and what does that matter?

Sir E. CLARKE: There was a known law and a known solvent, and all that the plaintiffs did was to ascertain the degree of strength of a solution. Having this knowledge, a man experiments. He tries first of all a strong solution, and finds that it is too strong; he reduces the strength until he succeeds, and then takes out a patent; but that is a bad patent.

LORD HALSBURY: Is not that assertion a little too broad? Take gunpowder. It is known that sulphur, saltpetre and charcoal will make gunpowder; surely the man who discovered the proportions of the different quantities which produced the most effective explosive would be entitled to protect his discovery by a patent.

Sir E. CLARKE: Gunpowder is a compound, but here the only question is one of degree of strength. A man reduces the strength of his solution by the addition of water, and when he arrives at a satisfactory result he takes out a patent, can it be suggested that, having before him the operation of a known law, and of a known solvent, his patent would be good? Prof. Crookes says it was known that a strong solution would act differently to a weak solution, which is only as much as to say that a great heat would have a different effect than a lower heat.

LORD JUSTICE LINDLEY: What do you say to this part of the professor's evidence, that until a few years ago he was not aware of the solvent action of cyanide of potassium on ores?

Sir E. CLARKE: Up to the date of the patents of Rae (1867) and of Simpson (1885), we have no specific mention in literature of the application of this solution to ore. There is mention of its application to fine divided gold, such as is found in these "tailings." The learned counsel then proceeded to deal with the evidence of Mr. Harland, Mr. MacArthur, and other witnesses, on this question of selection.

LORD HALSBURY: The result which you wish to arrive at may raise the question whether this claim of the plaintiffs is too wide, but that is quite beside the question which we have been considering up to this moment.

Sir E. CLARKE: The selective strength of the solution is the essence of the patent.

LORD HALSBURY: You cannot carry that further than this: The plaintiffs claim all strengths ranging from ¼ to 2 per cent; and it may be that the patentee is limited to degrees of strength between ¼ and 2 per cent. I do not say that that is so, but that is a matter which we have to consider.

Sir E. CLARKE: If that is so, then I should submit that the patent is bad. Mr. MacArthur said that in all the strengths he had tried there was selective action, and he had to try the efficiency of the strengths on ores from different parts of the world, and he found that they varied with each experiment.

LORD HALSBURY: That does not strike me as making it bad.

Sir E. CLARKE: Then the patent must cover every degree of strength which has been experimented with, which is too vague. Before passing on to consider Rae's patent taken out in the United States in 1867, the learned counsel desired to make a few observations about the electrical current, which was a part of the defendants' patented process, and about which it was said that it was a mere trick to use an electrical current at all. He then read from the shorthand note what took place in the Court below, and said the electrical current was abandoned after Mr. Justice Romer had stated that the results of the experiments before him were not satisfactory. The defendants thought they had a very good case without electrical action, and abandoned it, and were condemned to pay the costs occasioned by that part of their defence. Considering the circumstances under which this part of the case was given up, he objected to the observations of his learned friends that its introduction was a mere trick.

LORD HALSBURY: Having thrown electricity overboard, and having been ordered to pay costs for having set it up as a part of your case, you must put up with the observations of learned counsel on the other side, however unpalatable they may be.

Sir E. CLARKE recognised the position, and then read the material parts of Rae's specification in which electricity in conjunction with suitable liquids and chemicals, such as cyanide of potassium, would extract pure gold from rock ore expeditiously and with little expense. Here electricity was treated as a valuable part of the process, which otherwise was very similar to that of the plaintiffs, namely, to bring the ore in solution and then deposit the gold. The learned counsel then read the evidence, showing, according to his contention, that it was an anticipation of MacArthur's patent. He said the objection taken to Rae was that it was an electrical process. He then referred to Simpson's specification taken out in the United States in 1885, in which powdered ore was treated with cyanide of potassium and carbonate of ammonia, and recovering the gold after precipitation.

The Court again adjourned.

On Wednesday two interlocutory appeals having been placed first on the paper, the further hearing of this appeal was not commenced until about 3 o'clock in the afternoon, Sir E. Clarke being engaged in another Court at the time.

Mr. NEVILLE, Q.C., obtained their Lordships' permission to take up the thread of his learned leader's argument. He said that at the rising of the Court on the previous day Sir E. Clarke had practically exhausted all that he had to say with reference to Rae and Simpson's specifications, and it only remained to press on the Court the view taken by the defendants' counsel of the plaintiffs' claim. He submitted that when divested of the fine rhetoric with which Sir R. Webster had surrounded the subject, the issue was a very simple one, namely, could the plaintiffs sustain a patent which contained no trace of invention. All that had been done was to make use of knowledge at least a hundred years old, namely, that gold could be extracted by a cyanogen solution. The only merit of the plaintiffs' specification was that for gold ore of certain qualities a dilute solution was more efficacious than a strong solution; but that merit, as Sir E. Clarke had already pointed out, would not entitle the plaintiffs to sustain their patent. The patent must be for one of two things: either for the extraction of gold from ore by a solution containing cyanogen, or, secondly, for a dilute solution of cyanogen containing mixtures. In the first case there was clear anticipation, for it was well known that a cyanogen solution would extract gold from ore; and in the second place the patent failed because the patentee did not show the selective action of a dilute solution. The learned counsel then proceeded to refer to the provisional and final specifications, the first of which he said was too wide, and the second too vague. If the plaintiffs succeeded they would take away from the public the right of using cyanogen in any form for extracting gold from ores, and this would give them a monopoly of an important and far reaching character.

The Court again adjourned.

Planet Electrical Engineering Company, Limited.

In the Chancery Division, on Friday, a motion in the action Wallace v. The Planet Electrical Engineering Company, Limited, was heard by Mr. Justice Stirling.

Mr. W. F. Hamilton, who appeared for the plaintiffs, said that the motion asked for the appointment, as Receiver and Manager, of Mr. Claud Scott, secretary of the company. The plaintiffs held all the debentures of the company, amounting to £2,500. By the terms of these debentures, principal became due and payable if there was default in payment of the interest, which was to be payable half-yearly. The debentures were issued in 1893, and no interest at all had been paid; and in these circumstances the usual debenture-holders' action was raised for principal and interest.

For the company, Mr. Sheldon appeared, and consented to the order.

His Lordship accordingly appointed Mr. Scott receiver and manager of the company, but directed that he should not act as manager longer than six weeks without leave obtained from the Judge in Chambers.

Re United Kingdom Electric Telegraph Company.

Mr. Justice Kekewich, sitting in the Chancery Division, had before him on Tuesday and Thursday last week an application by Mr. Arnold Statham, on behalf of Mr. William Hind, in *re* the United Kingdom Electric Telegraph Company, Limited (in liquidation), asking for the appointment of a new liquidator of the undertaking. The applicant's case was that in 1860 he entered into partnership with Thomas Allen (now deceased), who held certain patents in telegraphy, together with the invention of the uniform shilling system. In respect to these rights applicant asserted the Post Office paid to the now deceased liquidator of the company £50,000, of which he (applicant) claims a share. This claim has now been through all the courts up to the House of Lords; and plaintiff's aim was, in effect, the revival of this litigation, which has extended over 30 years. To this end a preliminary step was the production of a resolution in the alleged nature of a trust for him, said to have been passed by the company, and contained in a minute book of which he has never been able to obtain possession. He now, in his examination, deposed to the memorandum of partnership, and that he made payments to the company in 1860; and there was called, on his subpœna, the solicitor to the company to produce this book. On the solicitor's behalf a clerk appeared, and said he could find minute books 1 and 2, but not 3, which contained the needed resolution.

Mr. Justice Kekewich (without calling on Mr. Witt, Q.C., with him Mr. Buckmaster, who appeared for the company), refusing, as he said, to encourage further litigation, and rejecting applications, first for an adjournment, and next for a non-suit, ordered that so much of the sums as had not already been dealt with, be dismissed with costs.

CORRESPONDENCE.

Argon and other Things.

Whatever may be thought about this curious gas, argon, it certainly has been the means, through the extraordinary patient and careful work of Lord Rayleigh and Prof. Wm. Ramsay, of directing the attention of thinking men to the subject of the complexity of the atmosphere, both physically and chemically, and we may expect substantial progress to result therefrom.

Argon might appear to have something to do with the production of nitrogen, but it is infinitely more probable that nitrogen has something to do with the production of argon.

Let it be said that no plant grows without a difference of electric potential between its parts, and between its contact surfaces towards earth and air, in which the plant, for all useful purposes here, may be looked upon as a collecting (from earth) and precipitating (from air)—and perhaps alternately so—piece of animation. Then to keep this up there must be a continual change going on, as we all know there is, both in the density and electric potential in different parts of the atmosphere. This is seen in a very marked manner just before, during, and particularly at the end of storms. The barometer sometimes jumps up an inch and more in the course of a quarter of an hour. These sudden changes in barometric pressure are always accompanied by a corresponding change in electric pressure, or ether gravity, or as we now dare say, ether disturbance or ether density.

So imagine the atmosphere, with such a large proportion of nitrogen, constantly subjected to these disturbances, ether and other matter tearing up and down and through it, in a manner impossible of anything like accurate description. Now, we know something of the effects of ether racing through, and ponderable collisions in, different gases; we know something of the production of nitrous and nitric oxides, ammonia, ozone, &c. These are comparatively easily formed, and, it follows, are easily decomposed; but let us say that argon is not so easily formed, but immensely more difficult, then it follows that it is in the same degree not easily unformed; that is, difficult to form, difficult to unform—a principle which holds good throughout created things.

The percentage of argon in the atmosphere is small; but how long has it taken to produce what there is. All elements, we may suppose, are formed, like all things animate and inanimate, by a principle of addition. This is a ground upon which to attack the theory of evolution. For example, on the lines that force, sensation, and consciousness may be, and are, in a progressive way shown in matter; but matter is not in the nature of force, neither is force in the nature of sensation, nor sensation in the nature of consciousness, but *vice versâ*; on the principle of addition from without, not evolution from within. Metaphysics will creep into physics, and very properly so, too, in the same way that consciousness is the master of unconsciousness. Whether force, sensation, and consciousness occupy space would be an interesting topic to start. We may commence at once by saying that they do. Most certainly the sensitive germ cell holding us did not occupy much space to commence with, but it contained force enough, in an architectural form, to produce our material form. Such thoughts as these are not unprofitable to gross materialists and others.

J. C. R.

Will you kindly allow me to make a suggestion with regard to an application for the supposed new atmospheric element, "argon," discovered by Lord Rayleigh and Prof. Ramsay. Granted that the existence of "argon" is undisputed, and that it is, as it is claimed to be, an "inert gas," could it not be applied with success, both practically and commercially, for filling the bulbs of electric incandescent lamps? It would thus replace the vacuum at present employed in the construction of incandescent lamps.

William W. Forster.

It is a pity for a technical periodical to lend its assistance towards fostering the absurd and wholly artificial *Times* bred scepticism with regard to the new gas.

The figures on which you criticise the "yield" in your issue of February 8th, page 159, are either erroneous, or are based upon a purposely *blank* or check experiment made by the discoverers with artificial air containing no argon, except what leaked in, to see what the result of their treatment would be in that case.

Oliver J. Lodge.

[It will be readily understood to whom Prof. Lodge alludes when he refers to *Times* bred scepticism, but we will allow that to pass. We fail to see cause for pity, and so that Prof. Lodge may be enabled to peruse something which even he could scarcely call absurd and wholly artificial scepticism, we beg to refer him to the *Chemical News* of February 8th and 15th, in which he will find articles by G. Johnstone Stoney, M.A., D.Sc., F.R.S., and Dr. Bohuslav Brauner, of the Bohemian University, Prague. The last paragraph of the latter gentleman's article is peculiarly suggestive of the leader we had the audacity to pen at the time "argon" was made known to the B.A. meeting at Oxford, and both papers may be read with profit, even by so eminent an authority as our correspondent.—Eds. Elec. Rev.]

The Welsbach Light.

A good deal has been said and written lately with regard to the Welsbach gas burner as a possible rival to the electric light, and a number of correspondents interested in the progress of electricity have been anxious to draw the attention of the public to the disadvantages attending the use of the Welsbach.

The question arises in my mind whether, from an electrician's standpoint, this is wise, for the incandescent gas burner is fulfilling a very useful purpose.

It is training the public to the use of a better light than

they have hitherto considered necessary, and any step in this direction is bound to prove advantageous to the electric light sooner or later.

There is no gainsaying the fact that the Welsbach burner gives more light for a given consumption of gas than was formerly considered possible, and when once used, I question whether any consumer will be content to return to the old fashioned burner.

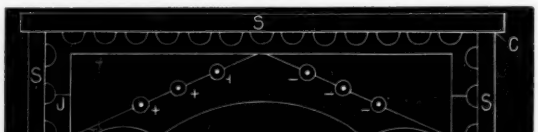
When, however, they have found out for themselves the drawbacks attending the use of this form of light, they will inevitably follow the example of many others during the past five years in adopting the electric light, which is the illuminant most conducive to health, luxury, and convenience.

I would suggest, therefore, that electricians should welcome the advent of the Welsbach gas as a means of arousing the well known apathy of the British public, and an advance which is bound to react in favour of the electric light in the long run.

Bernard M. Drake.

The Excelsior Conduit.

Perhaps the subjoined suggestion crowns all and is well worth the serious consideration of our Electrical Engineers. You will observe the conduit is corrugated, or fluted, and



s, Iron or stonewware slab; c, Cement, clay, or putty; J, Joint; v, Ventilation holes.

incased so that any escape of gas penetrating the outer shell, which may be composed of iron, can be driven out by forced draught, or drawn out by some perfect ventilating system. I don't think I need say more, as the drawing explains itself. Economy and efficiency is my aim.

Arthur E. Gilbert, A.I.E.E.

[Excelsior, indeed! We only hope that so far as Mr. Gilbert's correspondence is concerned that we can say *finis coronat opus*.—Eds. Elec. Rev.]

The Niagara Dynamos.

My attention has been drawn to a paragraph in your last issue, in which, while speaking of the dynamos now being erected at Niagara Falls, you say "alternators with outside revolving fields had been made by C. E. L. Brown" previously. I am fairly well acquainted with Mr. Brown's work, but have never seen one of his machines or his designs with this construction. May I ask you to kindly publish in your next issue the source of your information, because, if any prior publication of the principle exists, it would, of course, invalidate my American patent, No. 518,944; the matter is also of historical interest, since it was only by adopting this type of construction, which rightly or wrongly was supposed to be novel, that we were able to meet the requirements of the turbine makers at Niagara Falls.

George Forbes.

February 20th, 1895.

Small Inside Reflectors for Alternating Current Arc Lamps.

In No. 899 of your valued paper, you publish a letter from the firm Körting & Mathiesen, which calls for some reply, not because we consider the said firm experts in the decision as to the validity of our patent, or because we think the columns of your valued paper the proper forum where such controversy should be solved.

In their attempt to show the invalidity of our patent, they admit, although in disguised form, that they have copied our invention and construction, and while they reluctantly admit this, they try to cover their anticipated retreat by pointing out that it makes no difference whether a reflector is used *inside*, in close proximity to the arc, or whether such reflector is placed *outside* on the top of the globe.

We have no doubt that the reflectors used inside Körting and Mathiesen's lamps, in contravention to our patent, are of such inferior quality that the enamel will get useless in a very short time, as stated by Körting & Mathiesen themselves.

But it is quite a different matter when reflectors of the very best quality, and coated with a specially suitable enamel, are, as with the Helios lamp, used, in which case the results will be quite different to those experienced with Körting and Mathiesen's lamps.

The contention of Körting & Mathiesen that the reflector used outside on the top of the glass globe has the same effect as our smaller reflector fixed inside in close proximity to the arc, shows only the superficial knowledge (if any at all) of the rudimentary requirements of an effective Alternate Arc Lamp, that we need not dilate any further on it.

In Claim 7 of our patent, No. 18,245, we specify a bridge-piece immediately above the arc, constructed as a reflector, or a reflector attached to such bridge-piece, which in plain English means, that the reflector is the essential part, or there would be no need for describing two different manners how to construct and use such reflector.

The former system is literally copied by Körting & Mathiesen, with the only and quite irrelevant alteration, that they dispense with the guide-piece.

This, however, is not the only infringement of our patent committed by this firm, who now wish to pose as the champions of Arc Lamp manufacturers.

A glance at our patent, and at the illustration of Körting & Mathiesen's lamp, proves that the construction (under claim 2) of a lever which carries at its one end, a core of a solenoid, and at its other end a core acting as a dashpot, has been taken by Körting & Mathiesen as a model for constructing their lamp; and as we do not intend to submit quietly to this cheap system of saving expense for designing and constructing as adopted by Körting & Mathiesen, detrimental to our patent rights, this firm will have an early opportunity of finding out in a proper quarter, whether English patents may be waylaid with impunity or not.

We repeat our warning against buying or using Alternate Arc Lamps with a reflector in close proximity to the arc other than our make. We have instructed our solicitor to take legal proceedings against any infringers of our patent rights.

Thanking you for your courtesy in inserting our reply in your valued paper.

Helios, Actien-Gesellschaft fur electrisches licht, etc.

[We agree that the Review is not the "forum" for the settlement of this dispute, so here the controversy ought to end.—Eds. Elec. Rev.]

THAWING BY ELECTRICITY.

Mr. Edmunds informs us that he has been making some experiments lately with most complete success, in what we think is a new and important application of electricity to domestic use. He, like many others, has suffered the inconvenience of having his gas and water service frozen during the late severe weather. It occurred to him that a resistance, suitably protected, might be introduced into those pipes which were most exposed, and least easy of access with flame or hot water, or other ordinary method of thawing. He had a special wire made, in which the current was conducted through a highly resistant metal, insulated with a fireproof medium that was also a non-conductor of electricity. The whole was enclosed in a metal tube, which could be drawn down to make a compact wire or tube that was externally a conductor of heat, but not of electricity, thus preventing loss of current and electrolysis. The results were most satisfactory. This "thermic" wire was introduced into the waste pipe from a bath room at the north side of his house, which entered a fall pipe some 20 feet from the ground, and which was easily frozen. On Saturday last the thermic wire was

introduced from the outside. At night a small stream of water trickling down, froze, forming an icicle some 12 inches long and 1½ inch thick, completely blocking the waste pipe. The thermic wire having been previously connected with Mr. Edmunds's electric light circuit, at 50 volts pressure, when current was turned on 4 ampères flowed through it; and in four minutes a complete thawing was effected, and the waste service was cleared. This is a method of thawing which might be worth the consideration of gas and water companies; certainly it is one that highly merits the attention of prudent householders.

BUSINESS NOTICES, &c.

Now Ready.—The Universal Electrical Directory. This directory, which is now on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

Alverthorpe.—The Parish Council of Alverthorpe, near Wakefield, have decided that the village shall be lighted either with gas or electricity, and a committee has been appointed to formulate a scheme.

Battersea.—The Special Committee appointed to consider the question as to the cost and practicability of the Vestry adopting the electric light, is asking the Vestry to sanction the expenditure of £200 to engage an expert to assist them in their inquiries. They believe the Vestry will be in a position to apply for a provisional order themselves within 12 months, and they urge the Vestry to continue its opposition to the application to the County of London and Brush Provincial Electric Lighting Company.

Bolton.—It has been decided that from March 1st a uniform charge of 6d. per Board of Trade unit be made, subject to a discount of 10 per cent. for cash in 21 days.

Brighton.—The Lighting Committee recommend the purchase of No. 39, North Road, for £700, in order that the electric light works may be enlarged. Plans have been approved for electric lamps to be placed in East Street, West Street, Preston Street, Queen's Road, Old Steine, Pavilion Parade, Marlborough Place, Gloucester Place, St. George's Place, York Place, and London Road.

Coventry.—The committee room and electrician's room at the central station are to be heated by electricity.

Dublin.—Messrs. W. Curtis & Sons have secured the contract for the electric lighting of the accountant's department, General Post Office, Dublin. The total number of lamps provided for in specification will be 110, and the work is to be carried out from designs and under the directions of Mr. J. Howard Pentland.

Eccles.—By nine votes to five the Council has resolved to proceed with an electric lighting scheme to cost something like £20,000. It is estimated that the streets can be electrically lighted for about £780, or at a saving of something like £300 a year.

Edinburgh.—A sub-committee of the Town Council had before it, last week, applications for extension of the electric lighting system in the South Bridge as far as the Surgeons' Hall, and in the North Back of Canongate. Some conversation took place on the question whether the low tension or the high tension system should be employed for such extensions, and it was agreed to get a report from Prof. Kennedy on the subject.

Hampstead.—Messrs. Siemens Bros. & Co., Limited, are to be asked to keep in stock a mile of each kind of electric lighting cable for use in future extensions, the Vestry only to pay for so much as they may from time to time require. The Vestry intend communicating with the Board of Trade opposing the recommendations of Sir Courtenay Boyle regarding the construction of tranformer chambers in public thoroughfares. The engineer has been instructed to prepare a specification for the installation of electric light to the town clock, and Messrs. B. Verity & Sons, Mr. F. Taylor, and Mr. W. Thompson, have been asked to tender for the work.

Islington.—At the last Vestry meeting six members voted in favour of a motion moved by Mr. Varley requesting that a report be prepared of the work done in connection with the electric light installation up to December 31st, 1894, giving details of all the contracts entered into, and an immense amount of information on almost every point connected with the installation. By the rejection of the motion the Vestry has saved itself a large and unnecessary expenditure. A large majority of the vestrymen voted against it.

Liverpool.—The Corporation considered the lighting question on Monday. Some progress was made with respect to the negotiations for the acquisition of the Electric Supply Company's undertaking, and it is thought that it may be necessary for the Corporation to engage the services of an expert in electricity. It is also intended to hold a conference between the company and the committee.

Newcastle.—An electric lamp of 1,500 C.P. is to be erected in Westgate Road, opposite the Assembly Rooms. A report was recently presented on the lighting of Pilgrim Street, and with a view of improving a certain portion of this thoroughfare, and it was decided to erect seven new lamps.

Newport.—At the last meeting of the Town Council it was agreed to borrow £1,775 for the electric lighting of the Town Hall, market, baths, free library, and museum.

Redcar.—A petition signed by a large number of householders and tradesmen was, the other day, presented to the Urban Council in favour of the adoption of the electric light. The Council consequently decided to grant a concession to a private concern to undertake the lighting.

Rochdale.—A councillor asked the other day whether any action had been taken regarding the surplus steam at the sanitary works with a view to utilising it for the generation of electricity, and also what power of steam they were able to accumulate. The electric lighting committee have the matter under consideration, and will meet shortly to consider the entire electric lighting question.

St. Pancras.—The St. Pancras Vestry has appointed Mr. Thos. Cooper, M.A., assistant engineer at the Regent's Park electric light station. The Electricity Committee have decided that for the present it would not be advisable to abolish meter rents.

Southport.—The Electricity Committee are at present working almost to the utmost capacity of the station, and are desirous of extending it so as to make it three times the present length. They wanted to accept tenders for the work, but the matter has been referred to the general purposes committee for consideration.

Sunderland.—The Electric Lighting Committee have submitted an estimate of their requirements for the ensuing half year, viz., £1,357 19s. 6d. The expenditure is based on a maximum, and the income is estimated at a minimum, viz., £367 1s., leaving £990 18s. 6d. still to provide.

Taunton.—The surveyor reported at the Council's last meeting that, owing to the severe frost, 18 gas lamps had become frozen, and, owing to damage done to the wires by high wind, the electric light on one of the circuits went out.

Wakefield.—It has been decided to engage Mr. R. Hammond as electrical engineer to the Corporation, and to apply for powers to expend £20,000 in carrying out the first instalment of the proposed electric lighting works.

Wigan.—The Electric Lighting Sub-committee reported that the following firms were invited to submit electric lighting schemes and tenders:—Jno. Fowler & Co.; Corlett Electrical Engineering Company, Wigan; Mather & Platt, engineers; The Brush Electrical Engineering Company; Siemens Bros. & Co. The five schemes sent in were considered by the sub-committee, who recommended for approval that of Messrs. J. Fowler & Co., which is based on the employment of an alternating current system, being generated at an electrical pressure of 2,000 volts, and distributed over the area defined on the map as for the immediate installation to converters, of which there are to be ten (10) fixed in watertight compartments, and placed in positions as may be required to meet the demand for current. These converters will transform the pressure from 2,000 to 100 volts, and will connect or to a low pressure main, *i.e.*, 100 volts, to which consumers' services will be attached. The sub-committee ask for instructions to proceed with the preparation of drawings, &c., for the erection of boiler house, engine and dynamo house, &c., &c. They recommend that application be made for powers to borrow £16,000, to be expended as follows:—Generating and distributing plant, as per tender, £7,931, allow 10 per cent. for contingencies £793, buildings, £5,000, services, meters, &c, £2,276. The tenders sent in were as follows:—Fowler & Co.: High tension, inside plant £5,502, distributing plant £2,429, total £7,931. Brush Company: High tension, inside plant £5,189, distributing plant £1,796, total £6,985. Brush Company: Low tension, inside plant £6,079 10s., distributing plant £2,164, total £8,243 10s. Corlett Company: Low tension (copper strip), inside plant £5,743, distributing plant £2,978, total £8,721. Corlett Company: Low tension (insulated cable), inside plant £5,743, distributing plant £2,804, total £8,547. Siemens Bros: Low tension, inside plant £4,290, distributing plant £2,843, total £7,133. Mather & Platt: Low tension, inside plant £4,810, distributing plant £4,010, total, £8,820. The Town Council at their last meeting accepted Messrs. Fowler's tender.

Windsor.—At the Town Council's last meeting, Alderman Dyson moved that steps be taken to ascertain what amount of water-power can be obtained from the River Thames for the production of electricity for lighting and motive power purposes. Several councillors and aldermen present drew the mover's attention to the opinion of Mr. Shoolbred, which had already been given, and which was to the effect that there was no water to spare. Alderman Dyson considered that as it had been done at Worcester from the river Teme so it might also be done at Windsor from the Thames. In the end it was resolved that the Electric Lighting Committee consider and report as to the production of electricity by water-power. We understand that the gas interest is not small on the Council, and electric light matters may not have a very pleasant sailing.

Worcester.—A deputation from the City Council Electricity Committee the other day urged the guardians to light the workhouse by electricity. The matter has been referred to a committee for report.

Annual Dinner.—The *employés* of the electrical engineering department of the G.N. Railway (King's Cross branches), sat down to their first annual dinner at the Dr. Butler's Head, Mason's Avenue, E.C., last Saturday evening, February 16th. Altogether there were present over 100 persons, including everyone engaged in the telegraph and electrical engineering departments, whatever the position held. It is intended to hold a similar social gathering every year in future. The chairman was Mr. C. J. Cooke, the inspector at this end of the line. Messrs. Paget and Hill carried out the secretarial duties connected with the gathering to the entire satisfaction of the party present. A lengthy and varied programme of music and song followed the dinner.

Bankruptcy Proceedings.—At the Liverpool Bankruptcy Court last week, the Official Receiver stated that Loftus John Barnacle, electrical engineer, trading in South John Street, Liverpool, as A. Hall & Co., had not attended upon him since the last public examination, but he had written that morning to say that owing to the severity of the weather he was very ill, and would not be able to attend the adjourned examination.—The Registrar: The weather is not more severe for him than for you or me.—The Official Receiver: He asks for an adjournment for a week.—The Registrar said he was prepared to adjourn *sine die*, but he would give the bankrupt another chance, and adjourn the case to the 28th inst.

Book Received.—"Street Railway Investments. A Study in Values." By E. E. Higgins. Published by the Street Railway Publishing Company, New York.

Bristol Telephones.—The National Telephone Company are appealing against the assessment of their property and business at Bristol. Their gross rental was stated to be £1,976, and the rateable value £1,005, this being in respect of the wires over the whole of the city.

Calendar.—Messrs. E. Scott & Mountain, Limited, have sent us a calendar for 1895. It is about as neat as anything of the kind we have received. They have also brought out a folding speciality card showing some of the plant manufactured by them.

Catalogues.—A practical handbook has been issued by Messrs. Lazare, Weiller & Co., of Paris (whose London agent is Mr. Fernand Espir, of 3, East India Avenue, E.C.), which gives a great deal of information, tabulated and otherwise, regarding the products turned out at their electrolytic smelting works at Angoulême. From the following headings an idea will be gained as to the amount of useful detail contained in this small pamphlet of 50 pages:—Calculations, standard wire gauge numbers, corresponding diameters in mils and millimetres, electrical resistance of wires in ohms at 60° F. and at 0° C., rules for converting English weights and measures into the metric system and *vice versâ*, preliminary wire calculations, rules for calculating the weight of a conductor per kilometre. Chapter III. consists of a number of tables which give diameters, resistances, &c., &c., of various bronze and copper wires. These are only a few of the items which are dealt with. The immense amount of tabulated and general information cannot fail to be of the greatest value to Messrs. Weiller's customers, and we have great pleasure in drawing the attention of the electrical trades to this handy-sized and useful pamphlet.

Chadburn *v.* Mechan.—This case to which we have already referred, came on before Mr. Justice Romer on 15th inst., when judgment was given for the plaintiff with costs. An order was made for the delivery up of all infringing apparatus in the defendant's possession, and an inquiry is to be made as to damages. The defendant had mainly supplied the appliances to the Admiralty.

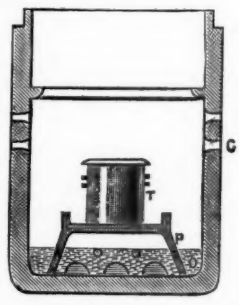
Dissolutions of Partnerships.—The partnership which has for some time past been carried on by A. W. Money and H. Nash at 19, Palace Gardens Mansions, High Street, Notting Hill, W., under the style or firm of Money and Nash, as electrical engineers, was on 11th inst. dissolved by mutual consent.

We are informed by Mr. John A. Edmondson that the partnership hitherto existing between himself and Mr. Wilson Hartnell, and carried on under the style of Wilson Hartnell and Edmondson, of Volt Works, Leeds, was on 19th inst. dissolved by mutual consent and arrangement. We understand that Mr. Edmondson has taken over the whole of the extensive new works on his own behalf, and will in future carry on business at the same address as a manufacturer of dynamos, motors, steam engines, mining, and pumping machinery, and also as general, consulting, and electrical engineer and contractor; the name of the works will be changed to Globe Electrical Works. All the machinery at the works, including the travelling cranes, are driven by electricity, and the whole of the establishment lighted by the electric light.

The partnership lately subsisting between Arthur Lewis and William Keene carrying on business as electric light and power engineers, at 7, Tudor Lane, Cardiff, under the style of Lewis and Keene, has been dissolved by mutual consent, as from the 6th day of February, 1895. All debts due to and owing by the said late firm in relation to the said business will be received and paid by Arthur Lewis, who will in future carry on such business alone, and in his own name.

Electricity in Mining Operations.—With reference to Mr. C. S. Corlett's paper, read before the Northern Society of Electrical Engineers, which appears in our last issue, we are asked to correct a printer's error which may be confusing. In the formula, in calculating the pipe friction, we gave "H" as the heat due to friction whereas it should be the head in feet due to friction.

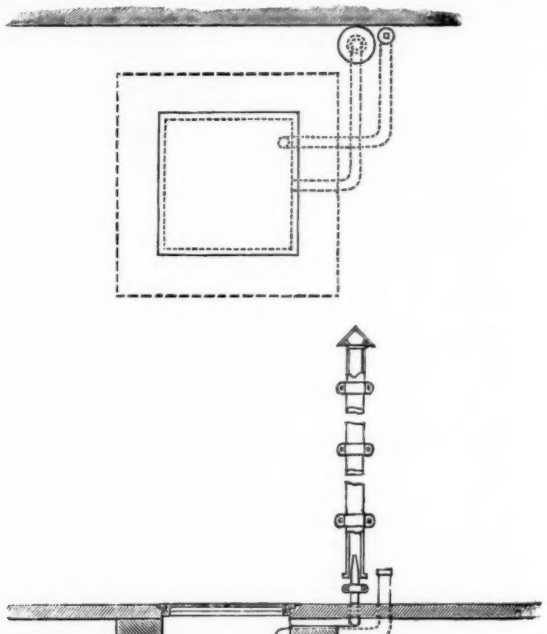
"Glenboig" Street Boxes.—We are now able to give a sectional sketch of the transformer boxes to which we referred last



C, Conductors packed on inside of box where they enter T, Transformer P, Perforated stoneware transformer support; O, Oil.

week. All conductors and leading in wires are thoroughly packed at the entrance to the box.

Improvement in Ventilation of Channels, Culverts, Boxes, &c.—In this new system, which has been patented by Mr. W. Alan Fraser and Mr. Geo. Bradley, the ventilation is induced by means of a small iron pipe about 2 inches diameter taken from the side of the box near the top and across under the pavement, either to the front of the adjoining houses or other available support, and then turned up above ground about a foot high. A larger pipe is fitted over this pipe, say about 4 inches down, leaving an annular space all round between the 2 pipes, and this larger pipe is run up to any convenient



height (8 or 10 feet) to induce a draught as shown in sketch. The annular space between the pipes being open, the air rushes up and draws with it any gas out of the box or culvert, and to us it seems to be well fitted for the purpose intended. In cases where the amount of accumulation of gas is very great, a secondary pipe to supply external air is introduced to lead the air from the outside into the bottom of the box, and consists of a small pipe about 1½ inches diameter carried underground alongside the ventilation pipe, and projects above the ground line about 9 inches and fitted over the top with a perforated cover to prevent dirt and matches, &c., being dropped down. This apparatus can be fixed to all existing boxes at a comparatively small cost.

Leeds Electric Tramways.—The *London Gazette* contains notification of an application to be made to Parliament in the 1895 session by the Leeds Corporation, which body seek powers to construct stations for generating electric power for the

purpose of working their existing authorised and intended tramways within stated limits.

Nalder's New Patent Ironclad Ammeter. — The working parts of this new instrument, of which we thoroughly approve, are screened by a cast-iron cover and base, which are of bold design and tastefully nickelled. The hardened steel pivots of the needle system are of a new type, and are machine ground and polished, and work in sapphire bearings, thus reducing the friction to a minimum. All portions of the moving needle are now soldered: this is particularly necessary in the case of alternating instruments on account of vibration. The hysteresis error has been decreased to such an extent as to be negligible through modification of the disposition of the soft iron needle, the result of a long series of experiments carried out under Messrs. Nalder's personal supervision. All ammeters are now made with sufficiently high insulation internally to allow of their being placed on high pressure circuits, say up to 2,000 volts. The firm have done this so that by making large quan-

tities of only one type, they are enabled to sell a highly insulated ammeter without extra charge. The cases are dustproof, no holes for ventilation being required. Gravity ammeters for use in accumulator circuits—specially where the dynamos are driven by gas or oil engines, and in alternating circuits where the dynamos run in parallel, and in both of which there are therefore violent fluctuations of current—can be damped by Nalder's new patent damper, at a small extra cost. Each instrument is individually calibrated against Messrs. Nalder's standards, and an enamelled scale prepared accordingly. All ammeters and voltmeters are sealed. The manufacturers have increased the number of standard sizes, for which all the parts are kept in stock.

Price Lists.—A circular just published by Messrs. J. P. Hall & Co., of Oldham, dealing with "electricity and water-power," contains some nice illustrations of their turbines and accessories, also prices and particulars of same.

From Messrs. Gent & Co. we have received a copy of their latest (February) price list of electric bell wire.

Rowland, Barnett & Co.—This Newcastle firm has been instructed to supply and erect a complete installation at the headquarters at Ryhope, of the Ryhope and Silksworth Co-operative Society. The plant consists of one 28-kilowatt compound-wound dynamo, and about 270 incandescent lamps and two series arc lamps. This firm are also supplying and fixing a complete electric light plant at the new Roman Catholic Church, Felling. In addition to the above, they have on order for the new Olympia, Limited, Newcastle, one 16 kilowatt compound-wound dynamo, switchboard, &c., and 170 16-C.P. and three 200-C.P. incandescent lights; also two series arc lamps.

Telegraphic Interruptions.—For some time past the Foreign Department at the Central Telegraph Office has been handicapped in consequence of mishaps to the North Sea cables. On Monday, however, the accumulation of work on the lines was greater than ever, owing to the breakdown on Saturday of two of the French cables—those between Dover and Calais and Folkestone and Boulogne respectively. There was accordingly considerable delay in the transmission of messages.

The Amsterdam Frauds.—Our readers will remember the warning we published some time ago regarding certain firms who were far from trustworthy, in Amsterdam and that district. The British Consul at that town (Mr. W. C. Robinson) writes to the daily press repeating the warning which he had already given to British firms, to exercise the greatest discretion in all their business relations with new firms in that part of the Continent. Mr. Robinson has very kindly offered to answer any inquiries that may be addressed to him at the British Consulate, Amsterdam, each inquiry to be accompanied by an English 2½d. stamp. He thinks it might be found practicable to form a General Protective Association, for the purpose of prosecuting and punishing swindlers of this class in foreign countries, whose victims are, as a rule, deterred from taking legal steps by a natural disinclination to throw good money after bad. Electrical firms trading with this part of the world will need to be on the alert, and immediately on receipt of suspicious or uncertain communications should write to Mr. Robinson, giving the names and addresses of the correspondents.

World's Exhibition at Amsterdam.—Applications for space will be received up to Friday next, March 1st. The Exhibition is to be opened in May.

CONTRACTS OPEN AND CLOSED.

OPEN.

Seaham.—February 28th. The Seaham Parish Council invite tenders for lighting the streets and roads of the parish with gas or electricity. Tenders to be sent to Rev. D. W. James, of whom any further information may be obtained.

Spain.—February 28th. The municipal authorities of Truxillo are inviting tenders for the concession for the electric lighting of the public streets of the town. Truxillo is an old town situated on the side of a hill near the river Magasca, in the province of Caceres.

CLOSED.

Belfast.—The tender of Messrs. W. T. Coates & Son for the fitting of guards round the engines in the central station has been accepted.

Wigan.—The tender of Messrs. Jno. Fowler & Co., Limited, for an electric lighting scheme has been accepted. Further details will be found in our "Business Notices."

NOTES.

Personal.—Mr. George Duffitt, who was for many years connected with the Edison and Swan Company, has been appointed by Froggatt's Electric Lighting Company, Limited, to proceed to Glasgow to take charge of the lighting of the Corporation tramcars, and to fit up a charging station at Coplaw Hill.

The Pacific Cable.—A Reuter's telegram of the 16th inst. from Ottawa states that the Minister of Trade and Commerce has announced that the lowest tender for a Pacific Cable between Vancouver and Australia and New Zealand, touching on the way at Fanning, Fiji, and Norfolk Island, is £1,517,000. This route appears to be No. 1 in the general conditions of tender, dated August 6th, 1894. The lengths given overground are as follows:—

Vancouver to Fanning	3,232 knots.
Fanning to Fiji	1,715 „
Fiji to Norfolk Island	1,022 „
Norfolk Island to New Zealand	415 „
Norfolk to Tweed Mouth, Australia	761 „
	7,145 knots.

It is interesting to compare the price given above with the estimate furnished by the General Post Office on July 5th, 1893. The engineer-in-chief then stated that for the Vancouver-Fanning section, a length of 3,298 miles, to secure even the moderate working speed of 12 words a minute, the cable must have a core of 940 lbs. copper and 940 lbs. gutta-percha to the knot, and he put the cost of manufacture and laying of such a cable at £600 a knot, or for this section alone a total of £2,374,200—allowing 20 per cent. for slack!!!

An important memorandum by Mr. Sandford Fleming, respecting the establishment of the Pacific cable, has been made public in Canada, and it states what are understood to be the accepted views of the Canadian Government. Acting under the resolution of the Conference, the Dominion Government called for tenders under three forms. By the first of these, Form A, the cable is to be owned and controlled by Government, to be worked under Government authority and to be kept in repair by the contractor for three years. The only actual offers received are according to this form. For more detailed information, we must refer our readers to the *Times* of yesterday.

Electrocution.—The *New York World* records the circumstances connected with the electrocution, on January 28th, of a negro named Hampton, who was convicted of murdering an old woman in New York. At 11.13.45, Hampton took his seat in the chair. At 11.15.13 the current was first applied. At 11.16.10 it ceased, and the four doctors in attendance pronounced him dead. The voltage applied was 1,740, which was maintained for four seconds. The pressure then fell to 150 volts for 37 seconds, after which it again went to 1,740 for three seconds. The *World* says that the rupture of the brain vessels, discovered by the autopsy, seems to dispose of the theory that an electrocuted man may be revived.

Registration of Debentures.—The *Financial Times* understands that the Bill introduced by Sir Albert Rollit, dealing with the registration of debentures, will provide for a public register of debentures at Somerset House, which shall be open to inspection, and that it will contain a further clause intended to prevent promoters from securing debentures for themselves to the detriment of the shareholders in the event of liquidation. Another clause provides that the Board of Trade shall initiate proceedings against companies which fail to comply with the Companies' Acts in regard to the filing of documents at Somerset House. It is to be hoped that the ever rampant party spirit will not prevent the passage of so useful and necessary an Act.

Argon.—At the last meeting of the French Academy of Sciences, M. Berthelot read an account of argon, and made several suggestive remarks on its characteristics. Speaking, for instance, on the subject of its inertness on the higher animals, he pointed out that it did not necessarily follow it would not have some action on bacteria, which it is known absorb nitrogen. He, therefore, suggests that nitrogen obtained from the total destruction of animal or vegetable matter should be examined for the newly-discovered constituent of the atmosphere.

The investigations of Lord Rayleigh and Prof. Ramsay will form the subject of one of the well-known popular lectures at the Royal Victoria Hall, Waterloo Road, S.E., on Tuesday, February 26th, at 8.30.

Royal Society.—Before this Society yesterday afternoon, the following papers were read:—Lord Kelvin, P.R.S., Magnus Maclean, and A. Galt, on "Electrification of Air and Gases by Bubbling through Water and other Liquids"; H. F. Newall, "Note on the Spectrum of Argon."

Royal Institution.—Lord Rayleigh, F.R.S., Professor of Natural Philosophy in the Royal Institution, will deliver a course of six experimental lectures on "Waves and Vibrations" at the Royal Institution on Saturdays, March 2nd, 9th, 16th, 23rd, 30th, and April 6th. He will also deliver the Friday evening discourse on April 5th, when his subject will be "Argon, the New Constituent of the Atmosphere."

The Light for London.—Surely nothing can hinder the progress of electric lighting now that the unofficial organ of the London County Council and the democratic party, has expressed an opinion so decidedly in its favour. That organ (the *Daily Chronicle*) has evidently a great dislike for gas, though from what we have heard we have reason to believe the parties in whose interests it wages war use more gas—and that not of the richest quality—than all other political parties together. However, in setting forth by an illustrated article a programme of municipalisation for the future governing body of London, the *Chronicle* selects a graceful figure bearing a banner with this inscription, "Municipal Lighting." The banner and the garb of the figure are decorated with a number of what we believe are electric incandescent lamps, but gas is completely ignored, even the Welsbach incandescent gas system not having a place. The time-honoured but now out-of-date wealthy Titans of the gas lighting industry, must have trembled with fear when the great *Daily Chronicle* refused it a future place in the lighting history of the metropolis. We have been watching for an alteration in the prices of gas stocks and shares since the publication of Monday's issue of the *Chronicle*, but as yet there is no marked change.

Canadian Mica.—Dr. G. M. Dawson, the Director of the Geological Survey of Canada, has sent to the Imperial Institute a collection of some 50 samples of Canadian mica. The export of this article from Canada to the United States, for electrical purposes, has steadily increased, and it would be as well if English electrical people were to make themselves acquainted with what Canada can produce in the way of mica. The samples are on view in the Canadian section, and we feel sure that Mr. Harrison Watson, the Canadian Curator, will give all information on the subject.

Flashes.—It is somewhat astonishing to learn from a contemporary that Mr. Trotter lectures *by letter* to the pupils and staff of Messrs. Crompton & Co. The useful information to be gleaned from its columns is still further exemplified by its mention of the increase of good *steel* engravings in the "big blue-book." And yet it is not difficult to discriminate between steel, wood, and photo-process engraving!

Cable Matters.—A despatch from Pretoria states that the negotiations between representatives of the South African States and the cable companies for the reduction of the cable rates between England and South Africa have reached an important stage, the Transvaal Government having agreed to pay an annual subsidy of £10,000 for 15 years, provided the tariff be reduced from 8s. 11d. to 5s. per word. We believe that the rate for Government messages will be reduced from 5s. to 2s. 6d. per word, and for press messages from 2s. 6d. to 1s. 3d. We understand that the proposals now under consideration will be submitted to the Volksraad at its next session, when we hope that in any arrangement which may be come to, the liberty of competition will be amply safeguarded.

The French Chamber of Deputies passed, on 18th inst., the vote of 180,000 francs (£7,140) for the laying of a submarine cable between Obock and Dijibouti, Tadjourah Bay at the French settlement on the African coast, nearly fronting Aden.

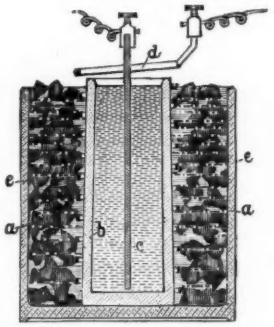
We learn that the ss. *Dacia*, belonging to the Silvertown Telegraph Company, left Cadiz, on the 19th, on her way to London, after completing the repair of the cable between Cadiz and the Canary Islands.

Government and the Telephone.—The Scottish members of Parliament are continuing their agitation against the telephone arrangements recently made by the Postmaster-General. They determined, at their conference on Monday, to enter into a balloting combination, in the hope of securing an early Tuesday for submitting to the House of Commons a resolution in favour of municipal control of the telephonic system. We understand there is likely to be a more or less heated discussion in the House shortly on the telephone question. It would seem that the talk will be similar to the discussion which took place at the County Council recently, for Mr. J. W. Benn gave notice on Tuesday that on 1st prox. he will move a resolution regarding the agreement between the National Telephone Company and the Post Office.

Temporary Blindness from Electric Shock.—The *Western Electrician* publishes the following note on the authority of the *Cincinnati Post*:—"John Sweeney, the engineer at the Main Street electric railway power house at St. Bernard, lost his eyesight while at work on one of the generators. He was engaged in sandpapering one of the machines when, in some manner, he grounded it, and there was a flash of fire that lighted up the whole engine room. Sweeney fell back as though shot, and when he made an effort to get away he discovered that he could not see. He was totally blind, and had to grope his way from the machine. The man thought his eyes had been blown out, so strong was the stroke. He called for assistance, and a physician was sent for. For two hours the man's sight was a total loss, and it was feared that the injury would become permanent, but, with the aid of soothing lotions, and being kept in the dark, his sight was restored. The flash was so hot that his left hand was badly burned, three fingers being nearly roasted to a crisp. After he was able to move about his injured hand was dressed, and he was taken to his home."

The Fire at Kensington Court Station.—The inquest into the death of the youngest child of Mr. John Holland, the foreman at the Kensington Court central station, was held on Saturday last, at Westminster. Evidence showed that the fire broke out about 10 o'clock on Tuesday, 12th inst., but the origin of it was a perfect mystery. One of the firemen, who examined the building after the fire was subdued, said it was evident that it broke out in the accumulator room, but he could give no clue as to its origin. The jury returned a verdict to the effect that the poor child died from suffocation.

The Clydebank Sensation Disclosed.—The following ketch from the Glasgow *Echo* is said to represent the marvellous battery of the Clydebank youths, which is nothing more than a poor form of the Daniell type: *a* represents the outer cell, and *b* the inner porous cell. The battery consists of a zinc rod, *c*, placed in the cell, *b*, and a vertical copper spiral, *d*, surrounds this cell, while between this spiral and cell, *a*, coal cinders, *e*, pieces of coke, or some such porous, carbonaceous, and absorbent material is packed. After numerous experiments had been made, covering a period of five years, and several inventions patented, the Messrs. M'Donald, according to the *Echo*, decided to use within the porous cell a solution of sodium chloride, or, in other words, common salt water, and within the outer cell a solution of copper sulphate. These chemicals are claimed to have the merits of cheapness, power, and constancy. The cinders being very porous and absorbent, condense and absorb the gases evolved, thus disposing of fumes (what fumes?) and preventing polarisation. As a result of the action set up in the battery, the cinders become coated with a thin film of copper, decreasing the internal resistance, and thereby increasing the current. The conductivity of the copper spiral is found to lessen the internal resistance. Now, Alex. M'Donald, in his letter to the Glasgow *Evening Citizen*, dated February 7th, deliberately stated that copper was not used (see ELECTRICAL REVIEW of last week, page 199). How does he reconcile this statement with the description of the battery which the brothers themselves gave to the *Echo* representative? However, whatever the Clydebank youths may assert now matters little, for the constituents of the battery being known, we can at once say that it does not possess a single novel feature; furthermore, the Walker-Wilkins element is decidedly its superior, although that is not saying much.



Now we will dispose of several of the *Echo's* statements. We emphatically deny that 18 M'Donald pint cells will register 35 volts, or that they will light the M'Donald's house with incandescent lamps aggregating 200 candle-power for 12 hours, at a cost not exceeding one penny. The electrical energy required at, say, $3\frac{1}{2}$ watts per candle-power, would amount to about $8\frac{1}{2}$ units which, at the ordinary selling price of 7d. per unit, is even then several times cheaper than it can possibly be produced by a primary battery. Finally, we will draw the attention of all whom it may concern to the fact that the "new patent" for propelling boats by electricity, by lowering a number of battery plates into the water, is not only silly, but very old, for years ago Trouvé suggested the same idea. Unfortunately for both the Frenchman and the canny Scots, only the E.M.F. of *one* couple is available when a number of battery elements are connected up and plunged into the same electrolyte. The large syndicate, and the several smaller ones, seem likely to buy the knowledge that any schoolboy attending technical classes should possess, at a heavy cost.

Eight Hours' Day at the Postal Telegraph Factories.—The Postmaster-General, accompanied by Mr. Walpole and Mr. Lamb, visited the telegraph factories at Holloway and Mount Pleasant on Saturday morning, and announced that the hours of work would be reduced to eight a day on and from March 1st.

Appointments.—Two of Prof. Jamieson's assistants at the Electrical Engineering Laboratory of the Glasgow and West of Scotland Technical College have just received appointments. One, Mr. William Murray Morrison, has been chosen by the British Aluminium Company, Limited, to assist them in their manufacture of aluminium by the electrolytic process. The other, Mr. David A. Ramsay, has been selected out of about 100 candidates to be an electrician at Helsby, in the works of the Telegraph Manufacturing Company, Limited. Mr. Ramsay had gained the Sir John Pender gold medal, first-class honours, and the diploma of the Glasgow and West of Scotland Technical College.

Lectures.—Mr. A. P. Trotter's second lecture to the pupils and staff of Messrs. Crompton & Co., at Chelmsford, was upon "Royal Roads to Calculation." A considerable number of calculating machines, instruments, and slide rules were shown, and were left at Chelmsford for examination and use. The mechanism of the Edmondson and Brunsviga calculating machines were explained by lantern photographs, showing these instruments in various stages of dissection. Some of the wide capabilities of the Edmondson machine, and the great simplicity and durability of the Brunsviga machine were demonstrated.

Before the Kilmarnock Philosophical Society last week Mr. J. G. Kerr delivered a lecture on "The Ether and Electrical Oscillations."

On the 8th inst. a lecture was delivered to members of the Liskeard Church Institute by Mr. W. H. Huddy, on "Atmospheric Electricity."

Before the monthly meeting of the Insurance and Actuarial Society of Glasgow, held last week, Mr. Sam Mavor, M.I.E.E., delivered a lecture on "Electric Lighting in relation to Fire Insurance."

At Wolverhampton, in Trinity School Room, last Monday, Mr. G. W. Fairall (of the Electric Construction Co., Ltd.) delivered a lecture on "Some Applications of Electricity," illustrated by experiments.

Cases of Shock by Static Discharge.—Writing to the New York *Electrical Engineer*, Mr. J. C. Henry says:—"A few months ago a friend of mine in Westfield, N.J., was badly shocked. His residence was wired for 50 volts. The lamps burned all night from a 1,000-volt transformer before and after the occurrence. He was standing on earth in the basement and wearing thin slippers, he undertook to turn on the light and thinks he only touched the insulated lamp switch; the flexible wires leading to this lamp were evidently grounded by contact with the hot air pipes. He was knocked down and his fingers slightly burned. My first impression was, that it was a scare from but 50 volts under favourable conditions. This conclusion excited so much indignation, that in an apologetical way I suggested another, which was that he had received a static discharge from the core of the converter. I believe the last to be the true one, and I think that the European practice of grounding the converter cores should be insisted upon in American installations. While I have no doubt it would be difficult to repeat this condenser effect, I think there may be times when it is liable to occur in most forms of translating apparatus. I have seen a man knocked over by contact with the core of a Gramme form of armature when the coils were being tested with a harmless magneto. In the early days of electric railroading I experimented with a form of controller where the circuit was broken between the armature and the track rails. On several different occasions, when the cars were standing *with the circuit broken*, the motorman observed a large flash, and upon examination found the armature grounded. In those cases the armature core had been carefully insulated from its supports; they however had been exposed to heavy fogs during the night, and sweated considerably when put to work in the morning."

Waterloo and City Railway.—The Commissioners of Sewers, on Tuesday, decided to signify their approval of the plan and section of the proposed works of this railway from Blackfriars Bridge to Queen Street, subject to their being carried out to the satisfaction of their engineer.

More Explosions.—On Friday evening last, about 6 o'clock, there was an explosion at Leicester similar to those which have occurred in other towns. The explosion, which occurred in Market Street, was followed by the extinguishing of the light in Market and Belvoir Streets. An iron lid of one of the chambers was blown off, and the chamber filled with smoke. Mr. Colson (the engineer) and some of his assistants were soon in attendance, and after switching off the current, made a thorough examination of the chamber. A local paper says the cause was the ignition of some waste and oil.

On Monday afternoon an explosion occurred in West George Street, Glasgow, the cover of one of the electric light manholes being blown off. Very little damage was done, and no one was hurt.

Propagation of Magnetisation in Iron.—The following is an abstract of the paper read last night before the Institution of Electrical Engineers, by J. Hopkinson, F.R.S., Past-President, and E. Wilson, Member:—The paper deals with the same subject as was dealt with by the same authors at a meeting of the Royal Society on May 31st, 1894, but the experimental work is carried out with larger apparatus. It has, of course, been long known that in electro-magnets with solid cores currents are induced in the solid iron when the magnetising current is reversed, and that these currents for a certain time retard the development of changes in induction. The length of time that these currents exist will be surprising to many. In the experiments which will be shown, a magnet of 12 inches diameter is used, and exploring coils are buried in its substance. These show how the change in induction occurs extremely rapidly near the surface of the magnet, less rapidly at some depths, and slowly at its centre. With certain magnetising forces it takes as much as four minutes before the change at the centre of the core attains a maximum. The application of the results to magnets with cores of other sizes is pointed out, and conclusions are drawn as to the appropriateness of general practice in regard to the sizes of wires or plates used in transformers. The experiments are made in part with the reversals of current in the magnetising coils, and in part with the currents of a slow alternating character. The slow alternating currents are produced by means of a liquid reverser substantially similar to one which was described by Prof. Ewing.

Mr. Crompton's Inaugural Address.—Concluding a leader on this subject, the New York *Electrical Engineer* says:—"In closing his address, Mr. Crompton stated it to be his duty to raise a note of warning against placing electric engineering works in the hands of very young engineers, whose experience had been a very short one, and he feared that the Institution itself was in some degree to blame for the state of affairs existing in England, owing to the fact that it had devoted its attention to thoroughly scientific matters, and thrust into the background the more prosaic matters which must be studied by those who hope to deal thoroughly and economically with the varying conditions of electric supply. He expressed the fear that the interchange of ideas, the comparison of experience, the exchange of statistics, &c., existed chiefly among the older members of the profession, and, although they were most willing to impart what they knew to their younger brethren, they were, practically, never asked to communicate the results of their experience. The information, which Mr. Crompton here shows to be confined to so few, is that which our own National Electric Light Association was designed to disseminate, and it might not be out of place here to suggest to our English cousins the formation of a society based on the same lines. In this country, the management of the Institute of Electrical Engineers has great difficulty in keeping the mathematical papers within bounds; yet when it ventures on practical, useful, close-at-hand subjects, some one is sure to jump up and howl about mproper 'advertising.'"

Indian Telegraphs.—We hear that a new telegraph cable is to be laid between India and Ceylon in March, the old one which was put down in 1865 being abandoned.

The Northern Society of Electrical Engineers.—The Council have elected Mr. S. Z. de Ferranti a Vice-President of the Society, in place of the late Mr. G. E. Preece.

Erratum.—In Prof. André Blondel's article last week on "Dioptric Glass Shades and Holophane Globes," a slight error occurred in the letterpress under fig. 2. Instead of "Trotter" flutings, read "inner" flutings.

The Institution of Junior Engineers.—On Saturday, 23rd February, the members will visit Messrs. Siemens Bros. and Co's Works, Woolwich. Reception by the President, Mr. Alexander Siemens. Train from Charing Cross 9.20 a.m.

On Friday, 1st March, Meeting at the Westminster Palace Hotel, at 8 p.m., a paper on "Locomotive Repairing Work," by Mr. A. H. Newsam Smith, member, is to be read and discussed.

Electric Signalling on the Great Western Railway.—At the meeting of the Great Western Railway last week, Viscount Emlyn, the chairman, said that in the general charges there was an increase of £2,630, which was practically entirely due to the electric telegraph expenses. The board were increasing the means of communication upon the line by electric appliances and telephones, as they believed that by so doing they would add to the security of working the line, and also reduce the cost of working by having rapid means of communication between one point and another. He felt sure that in the future the company would reap considerable benefit from that outlay.

CITY NOTES.

Electricity Supply Companies.

There are several reports and accounts of electricity supply companies to hand, which we shall be unable to deal with very fully this week. If all supply companies were to publish along with their accounts a statement of electricity generated, sold, &c., during the year, it would be both interesting and convenient. There is a wonderful diversity of method adopted in the various electricity supply companies' accounts. Some consider a few plain statements and simple figures the most instructive and useful, while on the other hand there are companies which present their accounts in great detail to the shareholders. There is a good deal to be said in favour of simple methods; but after all, the Board of Trade system of accounts is fairly easy to comprehend after some experience; and as these are compulsory, it might save trouble to submit similar statements to the shareholders. In this respect it is interesting to record that at the meeting of the Westminster Company, held on Wednesday, a tentative resolution was adopted to dispense with the company's auditor, it being held that the audit performed by the Board of Trade ought to be sufficient.

It is a most gratifying feature to find, from the reports of 1894, that electric light companies are becoming really paying concerns. There is one feature, however, prominent; that is, the difficulty the older companies seem to experience in getting into the dividend paying condition.

Of the accounts to hand, only two give information sufficient for an analysis, the Notting Hill Gate and the National Electric Light Company (Preston).

The Cambridge Electric Supply Co., Limited.

We note that this company is moving with the rest. During the last twelve months, lamps equivalent to 3,644 of 8-candle-power have been connected to the company's mains, making a total of 11,644. For the purpose of meeting the low day-load, a small plant is to be provided. This is a step in the right direction. Up to October of last year this

company was obliged to stop the supply during certain hours of the night. Such an arrangement must have been an unfortunate one both for company and customer, and we were glad to see the limitation abolished.

A profit on the year's working of £933 1s. 1d. has been made, which, added to £268 brought forward, leaves a balance of £1,201. It is proposed to pay a dividend of 2½ per cent., absorbing £575, which, with £350 debenture interest, leaves £274 for depreciation, &c. With the assistance of Mr. Barker, the general manager, however, we hope to examine the accounts in greater detail.

The Northampton Electric Light Company.

The sixth annual report of this company records that the position of the company continues to improve in every respect. Frankly, we should like to see it improve much more. To show, after six years' working, no bigger lamp connection than 5,300, does not say very much for the enterprise of Northampton people in taking up electric light.

The net revenue is £662, against £536, while the cost of production is stated to be decreasing. £100 is carried to depreciation account, while £170 pays the dividend on the preference shares to the end of 1893.

City of London Electric Light Company.

To deal adequately with the accounts of this company is no small undertaking. We are not able to do them full justice this week, however, owing to the lack of information as to the number of units sold. Last year we believe that a comprehensive statement of electricity sold, &c., was supplied, but for some reason or other no statement is given this year.

The total revenue for the year was £69,380 3s. 3d., from which must be deducted the following items charged against revenue:—Expenses of generation and distribution, rents, rates, taxes, and general charges, £34,515 0s. 9d., leaving a net revenue of £34,865 2s. 6d., to which must be added the balance brought forward from 1893, £3,041 14s. 9d., making a total available revenue of £37,906 17s. 3d.

Of this sum the following amounts have been distributed:—

(*a*) Interest on debenture stock to December 13th last	£3,154	3	4
(*b*) Interim dividend on £400,000 6 per cent. preference shares for half-year to June 30th last	12,000	0	0
	15,154	3	4
Leaving for further distribution ...	£22,752	13	11

As we have already announced, the directors recommend the following dividends for the past half-year, viz.: 6s. per share on the preference shares, being at the rate of 6 per cent. per annum, and 5s. per share on the ordinary shares, being at the rate of 5 per cent. per annum. This will absorb £22,000, leaving a balance of £752 13s. 11d. to be carried forward.

Out of the premiums already received on the issues of debenture stock, the directors have decided to write off the whole of the expenses in connection with the issues of ordinary and preference shares, debenture stock, and other preliminary matters, amounting in all to £19,064 18s. 4d., and to transfer the sum of £1,585 11s. to the reserve fund, leaving a balance of £41,923 18s., which it is proposed for the present to carry forward.

The report states that the generation and distribution expenses for the year, including repairs and renewals, were 46 per cent. of the earnings, as compared with 54·2 for 1893.

It must be gratifying to shareholders of this company to know that revenue is now being earned at the estimated rate of over £105,000 per annum gross.

The following table is indicative of the rapid, if not extraordinary, progress made.

	End of December, 1892.	End of December, 1893.	End of December, 1894.
Estimated gross revenue from private lighting	£16,193	£45,738	£88,000
Estimated gross revenue from public lighting...	£11,259	£12,933	£13,600
No. of 8-c.p. lamps connected ...	20,241	65,341	135,460
Number of Customers	242	1,080	2,740

Nearly 3,000 private customers, representing 142,500 8-C.P. lamps, are being supplied with current, and applications are coming in.

Notting Hill Electric Lighting Co., Limited.

The revenue accounts show a profit of £2,401, as compared with profits of £1,481 in 1893, and £112 in 1892. The amount received from the sale of current shows an increase of £687, and the expenditure shows a decrease of £127. There is an available profit of £1,243, which it is proposed to distribute as follows:—

	£	s.	d.
(1) Dividend of 6 per cent. on the ordinary preference shares	566	6	0
(2) Dividend of 2s. per share on the ordinary shares	645	4	0
Carried forward	32	4	7
	£1,243	14	7

The following is the analysis of the cost of working:—

	1892.	1893.	1894.
Total capital expended	—	—	£78,335
Number of units sold	—	—	130,266
Number of lamps connected ...	—	—	15,699
Revenue from sale of current ...	—	—	£4,194
Net revenue	—	—	£2,401
Average price obtained per unit..	—	—	7·7d.

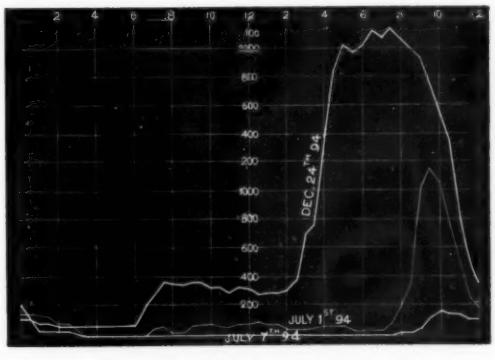
Cost of production.	£	s.	d.	Per unit.
Coal	459	12	0	·84d.
Oil, waste, water and engine room stores	112	9	6	·20d.
Salaries and wages at generating station	354	1	0	·65d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	512	6	7	·94d.
Rates and taxes	—			—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,094	7	7	(Works cost 2·63d.) 2·01d.
Depreciation of buildings and plant account	776	3	2	1·42d.
Renewal fund account	—			—
Total	£3,308	19	10	6·12d.

Revenue.				Average price obtained per unit.
By sale of current	4,194	8	8	7·7d.
Meter rents	230	17	0	
Sale of lamps	—			—
Total				7.7d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·70d.; works cost, 2·63d.

National Electric Company.

The report of the National Electric Company, Preston, is a fairly satisfactory document. The income for 1894 has increased by £1,443 8s. 5d., and notwithstanding the additional sale of current, the total expenditure on revenue account has been reduced by £561 17s. 1d. There is no doubt that great economy has been effected, as will be seen from the subjoined analysis. A consideration of the sort of load curve which



this company obtains, given herewith, makes the economy still more marked. Judging from the summer Sunday load curve, it would be a great boon if the station could be early closed on that day. We un-

derstand from the report that there is a growing demand for current for motive power and cooking purposes.

	1892.	1893.	1894.
Total capital expenditure ...	—	£59,962	£64,080
Number of units sold	—	—	220,867
Number of lamps connected ...	—	—	—
Revenue from sale of current...	—	—	£4,619
Net revenue	—	—	£995
Average price obtained per unit	—	—	—

Cost of Production.	£	s.	d.	Per unit.
Coal	752	5	1	·81d.
Oil, waste, water, and engine room stores	153	19	8	·16d.
Salaries and wages at generating station	800	5	9	·87d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	374	13	8	·45d.
Rates and taxes	264	19	2	·28d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,236	1	9	(Works cost 2·29d.) 1·34d.
Depreciation of buildings and plant account (bad and doubtful debts, £11 8s. 9d.)	—			—
Renewal fund account	30	0	5	·03d.
Total	£3,672	4	1	3·94d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	4,619	16	6	5·02d.
Meter rents	156	9	7	
Total	£4,776	6	1	5·02d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·94d.; works cost, 2·29d.

Isle of Man Tramways.

THE first annual meeting of the Isle of Man Tramways and Electric Power Company, Limited, was held at Douglas, on Wednesday, Mr. A. Bruce presiding.

The CHAIRMAN, in moving the adoption of the report, congratulated the shareholders on the magnificent position of the company. Dr. Hopkinson had reported that the property was in a highly satisfactory state. With the interim dividend already paid, the company had paid 15 per cent. on the ordinary and 12 per cent. on the preference shares, and had £7,753 available for contingencies. With the prospective improvements and attractions of the Park golf-links, and the Snaefell Railway, the revenue of the company would be increased.

It was stated that during the eight months the line had been open a million and a quarter of persons were carried.

Westminster Electric Supply Corporation.

THE ordinary general meeting of this company was held at the offices, Eccleston Place, on Wednesday.

Mr. J. H. POWELL, who presided, said that when their company was started, the chief aim of the directors was to give the public a constant, safe, and bright light, without danger to anyone. They had had the advantage of eminent engineering and architectural advice, and so successful had they been, that in the short space of five years they had reached a gross revenue of £52,646. Every year had shown an improvement in their position. They were now able to declare a dividend for the half-year at the rate of 6 per cent. per annum. The ratio of costs to revenue had been constantly decreasing. In 1892 it was as much as 59·4 per cent., but they had now reduced it to 45·5 per cent, notwithstanding the diminution in their charge for current from 8d. to 6d., a measure which they believed had been very wise, as it had induced many more to come on their circuit. In 1892 their expenditure per lamp installed was £3·56, whereas it had now been reduced to £2·45. They believed, too, that it would be further decreased, as the board had already laid distributing mains very widely in excess of immediate demands, so that they might be able to take in any number of lamps offered to them at any particular time. They had instituted a new system of bonus to their engineers and workmen, and this seemed to have acted advantageously to all concerned, their employés, the shareholders, and the consumers. Their net revenue in the past year was £25,055, which was more than 6¼ per cent. upon the whole of the capital engaged in the business, including, of course, the debenture capital. From this amount, however, they had to make some deductions as prudent men. They had, for instance, done away with the item of cost of patents, which, however, was a very proper charge to put to capital at the inception of their business; and they had written £2,000 off the preliminary expenses and £2,500 to a sinking fund. As regarded the last-mentioned item, the concession for electric lighting did not extend beyond 42 years from the date of the order, and although few of those present would see that time, he did not think they ought to avoid the responsibility of providing for their successors. If they did not have a reserve fund, and a considerable alteration were made in their machinery, or some new principle was evolved for making electric light, they would have nothing to dispose of at the end of their term, and it was very likely they would not be able to raise sufficient money to carry on their business. He concluded by moving the adoption of the report.

Mr. BOULNOIS, M.P., seconded the motion.

A resolution was then proposed by Sir MARK STEWART, M.P., to the effect that the appointment of auditors should stand over to an adjourned meeting in order that a communication might be made to the Board of Trade with a view of economising the expense of the annual audit.

Mr. DARNTON HUTTON seconded the motion, which was adopted.

A resolution was afterwards passed increasing the directors' fees from £800 to £1,500 a year, the advance to date from the beginning of 1894.

Charing Cross and Strand Electricity Supply Corporation, Limited.

MR. G. H. B. GLASIER presided at the meeting held yesterday. He said there was an important advance in the number of lamps supplied with current—about 20 per cent. The expenditure which was put down for mains laid was not necessitated by the connection of these extra lamps, but they were laid with a view to strengthening the position of the system, generally enabling them to meet any extra demand. During the seven weeks of this year they had already added 2,721 lamps to their output, and they had increased their weekly average output to the extent of 25·21 per cent. over the corresponding weeks of the preceding year. This showed that the company were still rapidly increasing their supply. They had written £485 off preliminary expenses, which left only £700 on that account still to be dealt with. £1,600 had been carried to depreciation account, which the directors considered a wise sum. In 1893 they wrote off £700, but for 1894 they increased this by £900, and this was equal to ½ per cent. on the entire share capital of the company. This sum was not so placed because of any faults in the machinery or mains—which are in a very high state of efficiency, almost as good as new—but it would make the company stronger. £150 had been deducted for bad debts. Their revenue had increased by £1,740, although current had been supplied at ¼d. per unit less than in 1893. Had they, during 1894, been able to charge the same per unit as was being charged when they brought out their prospectus, there would have now been an additional £10,000 odd for distribution as dividend, making it about 11¼ per cent. for the year. This, however, they had not been able to do because of competition. The company are seeking powers for lighting a certain portion of the Strand district; they do not propose to issue the authorised debentures until this provisional order has been settled.

After some further remarks the CHAIRMAN moved the adoption of the report, and the declaration of a dividend, making 4½ per cent. for the year.

Mr. W. W. ROBERTSON seconded the motion, and the retiring directors and auditors having been re-elected, a resolution was passed authorising, in accordance with the Board of Trade requirements, the placing of the sum for bad debts to debit account.

Edison & Swan United Electric Light Company.—An extraordinary general meeting will be held at the Cannon Street Hotel on Thursday, the 28th inst., at 3 o'clock, to consider and confirm as special resolutions the resolutions passed at the extraordinary general meeting held on the 5th inst.

Telegraph Construction and Maintenance Company, Limited.—The transfer books will be closed from the 18th inst. to 26th inst., inclusive, preparatory to the payment of dividend to all shareholders on the register on the 18th inst.

The Brush Electrical Engineering Company, Limited. The debenture stock transfer books of the Brush Electrical Engineering Company, Limited, will be closed from February 19th to March 2nd, both inclusive.

Faure Electric Accumulator Company, Limited.—A meeting is to be held at 14, George Street, Mansion House, E.C., on March 18th, at 12 o'clock, to receive an account of the winding-up.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 17th, 1895, amounted to £998; week ending February 18th, 1894, £938; increase, £60; total receipts for half-year, 1895, £7,039; corresponding period, 1894, £6,665; increase, £374.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending February 17th, 1895, amounted to £843; corresponding week last year, £671.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 15th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited were £3,388.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, February 13th.	Closing Quotation February 20th.	Business done during week ended February 20th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	101 —104	101 —104	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	40 — 41	40 — 41	40¾	40
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	75½— 76½	75½— 76½	76⅛	75½
2,993,560£	Do. do. Defd.	Stock	...	...	...	6½— 6¾	6½— 6¾	6¾	6½
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	11½— 12	11¾— 12¼	12	11¾
75,000£	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	109 —113	109 —113	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10%‖ §	... §	...	2½— 3½	3 — 4	3½	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	148 —152	148 —152	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14 xd	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21 xd	20	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	4 — 4½	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9½— 10	9½— 10	...	...
30,000£	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	2⅝% §	2 %	8½— 9	8½— 9	8 11/16	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	16¼— 16½	16¼— 16½	16½	16 5/16
70,000	Do. 6 % Pref.	10	6 %	6 % §	...	17½— 18	17½— 18	17⅞	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	..	...
1,297,837£	Do. 4 % Mort. Deb.	Stock	4 %	4 %	-	124 —127	124 —127	125½	125
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17 — 17¼	17¼— 17½	17½	17⅛
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	102 —106	103 —107	103½	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	103 —106	104 —107	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	123 —126	123 —126	124	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	102 —106	103 —107	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	...	103 —106	104 —107	106	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	...	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115%	112 —115	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	...	9½— 9⅞	9⅝— 9⅞	9⅞	9⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	...	16½— 16¾	16⅝— 16⅞	16⅞	16⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	...	21¾— 22¼	22 — 22½	...	...
190,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	106 —109	106 —109	108½	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	52 — 54	53 — 55	54	53¼
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½ %	...	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	...	105 —109	105 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	¼— ⅜	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	6 %	6 %	...	1½— 2½	1½— 2½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5⅜— 5⅝	5½— ¾	5 11/16	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15 — 17	15 — 16	15½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	15 — 16	15 — 16	15 11/16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	6 — 6¼	6 — 6¼	6 3/16	6¼
1,100,000£	Do. 3½ % Deb. Stock Red.	...	3½%	3½%	...	104 — 106	104 —106	106	105½
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... — ...	... — ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	9/16— 11/16	9/16— 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	...	3 — 4	3 — 4	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	118 —123	118 —123	121¼	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	86 — 91	86 — 91	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	0 %	...	4 — 5	4 — 5	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	103 —106	105	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	98 —103	98	...
64,245	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3½%	10¼— 10⅝	10¼— 10⅝	10¼	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	5 %	5 %	5 %	6¼— 6⅝	6¼— 6⅝	6⅝	...
33,129	Do. do. do. 5 % Def.	7½	...	...	...	4 — 4½	4¼— 4⅝	...	...
171,900£	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	100 —104	101 —105	...	...
214,800£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	100 —104	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	⅛%	1 — 1¼	1 — 1½	1⅛	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	10⅜— 11¼	10⅜— 11¼	11¼	11 3/16
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	108 —111	108 —111	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	115 —120	115 —120	...	...
166,900£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	104 —106	104 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5 — 5½	5 — 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	2½%	13½— 14½	13½— 14½	14⅛	14
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 15⅝	15½— 15⅝	15½	15⅝
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7¼— 7⅜	7¼— 7¼	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	2 %	2½%	...	9¾— 10¼	9¾— 10¼	10⅛	9 11/16
100,000£	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	118 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	7 — 7½	7 — 7½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7¼%	4½%	6½%	7¾— 8½	7½— 8 xd	7⅞	7¾
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¾— 9¼	8½— 9 xd	8⅞	8 13/16
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7½— 8	7½— 8	7 15/16	7¾

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Feb. 13th.	Closing Quotation, Feb. 20th.	Business done during week ended Feb. 20th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	2⅝— 2⅞	2⅝— 2⅞	2⅞	2 11/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2⅞— 2⅝	2⅞— 2⅝	2 7/16	...
125,000*l*	Do. do. 4½ % Deb.	Stock	4½%	4½%	...	115 —118	115 —118	...	...
630,000*l*	City and South London Railway	Stock	⅝%	⅝%	1¼%	48 — 50	46 — 48	48¾	47¼
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	3 — 3½	3 — 3½	...	...
50,000*l*	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	...	102 —107	102 —107	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	*nil*	*nil*	...	¼— ½	¼— ½	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1½— 2	1½— 1¾	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	...	1/16— 3/16	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1⅛— 1⅜	1⅛— 1⅜	1⅜	1 3/16
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1 — 1¼	1⅛— 1⅜	1 5/16	1 1/16
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½— 1½	½— 1½	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	...	9½— 10½	9½— 10½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	22½— 23½	23 — 24	23¾	22¾
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	8¾— 8⅞	8 9/16— 8 11/16 xd	...	...
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	13 — 13½	13 — 13¼ xd	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	42 — 44	43 — 45	46¾	43½
150,000*l*	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2⅜— 2⅝	2⅜— 2⅝	2½	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6¼.
Electric Construction Corporation, 6 % Debentures, 79—82.
Electric and General Investment, shares of £5 (£1 paid), 1¼—⅜
House-to-House Company (£5 paid), 3⅜—⅞.
Do. do. 7 % Preference, of £5, 7¼—⅜.
Do. do. 6 % Debentures of £100, 107—109.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7¼—7⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7¼—7⅜.
Liverpool Electric Supply, £5 (fully paid), 7¼—7½
London Electric Supply Corporation, £5 Ordinary, ½—⅝.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 98—102.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¼—5⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

ON SLOW CHANGES IN THE MAGNETIC PERMEABILITY OF IRON.*

By WILLIAM M. MORDEY. Communicated by Prof. SILVANUS P. THOMPSON, F.R.S.

When iron is magnetised for a long time by rapidly alternating currents, its magnetic permeability is usually reduced, a gradual increase taking place in the amount of energy absorbed in producing a given magnetisation. This effect has been observed in connection with the working of transformers on alternate current systems. Although it has been known for some time to a few electrical engineers, the author is not aware that any investigation or proof has been published as to the cause of this change†

When the author first became aware of this increase, he investigated the subject in connection with the work of the Brush Electrical Engineering Company, and to that company acknowledgments are due for permission to publish the results so far obtained. It may be mentioned that the investigation is still in progress.

In the first place explanations were sought in direct connection with the magnetic or electric actions that take place.

The explanation that first suggested itself was that eddy currents were being set up in the coils by leakage or partial failure of the insulation between adjacent portions of the conductor, or that eddy currents were being set up to an increased degree in the iron by disturbance or change of the insulating material interposed between the thin plates of iron of which the transformers were composed. A careful examination showed that this explanation was untenable. The increase was found in transformers, the coils of which were thoroughly dry and well insulated, and in which no change had occurred in the separating material between the plates. This was confirmed by removing the iron and trying it with new coils specially insulated—also by trying the old coils with other samples of iron which had been separately tested.

Another explanation suggested was that the effect was a sort of magnetic fatigue—that the iron deteriorated somewhat in the same way as with steel springs, which suffer from "fatigue" after a great number of extensions or vibrations.

The gradual increase in the energy absorbed pointed to a physical change in the iron, which behaved exactly as if it slowly hardened and so became less permeable—as if the softening results of the process of annealing were being gradually lost.

Effect of Annealing.—On carefully re-annealing some of the iron by heating it to redness and cooling slowly, it entirely recovered its original high permeability.

Having thus found that the iron was not permanently or irremediably affected—although apart from annealing the effect seems to be permanent—it remained to ascertain whether the change was due directly to the magnetic action, or whether it was caused by some secondary condition, having the reversals of magnetism as a primary cause.

Effect of Heat.—An investigation was therefore made as to the effec of heat on the iron.

Under the conditions of working, the temperature of the iron in transformers is raised, both by the energy dissipated in the iron itself by hysteresis and eddy currents, and also by conduction and radiation from the copper windings forming the primary and secondary conductors. This rise of temperature varies according to the conditions of working and the construction of the transformer; usually it is from 20° to 60° C. above the surrounding atmosphere.

In order to investigate the action of heat, as distinct from magnetic or electric action, some samples of iron were kept for some

* Paper read before the Royal Scciety. Received December 19th, 1894.

† The following are the only published references to this subject, so far as known to the author:—

In the *Electrician* of December 7th, 1894, the subject is introduced by Mr. G. W. Partridge, with some examples of the increase, and a statement that the effect is due to a "molecular change or fatigue in the iron."

There is also a note by Prof. Ewing referring to Mr. Partridge's article, also ascribing the effect, if confirmed, to "a progressive magnetic fatigue."

In the same journal for December 14th, 1894, there is an article on the subject by Dr. Fleming, stating that the effect is not general, that he has failed to find it in some cases, and pointing out that differences of temperature at the times of testing may account for the variations observed.

Mr. R. T. Smith states that in one sample of iron he has found considerable increase after about 240,000,000 reversals.

Mr. O. T. Blathy, of Buda-Pesth, states that he is familiar with the effect, that the loss in magnetising transformers increases from 20 to 25 per cent., and that artificial heating of the transformer for several hours to about 150° C. will have the same effect, which he states is permanent.

Sir David Salomons also states that he has referred to the effect in a work written some months ago.

months in an oven maintained at temperatures varying from about 60° C. to about 75° C. These samples were of iron obtained for transformer construction, and were built up in the manner of transformers, having windings which were used simply for testing purposes.

Method of Measuring.—The coils used were of known turns and resistance. The wire was of such a size as to make the $c^2 R$ loss negligible in comparison with the losses in the iron. The power was measured by a very sensitive wattmeter, constructed by Dr. Fleming, the volts by a Cardew voltmeter checked against a Kelvin multicellular electrostatic voltmeter, and the current by a Siemens electrodynamometer. These were instruments in regular use for manufacturing purposes, and used in fixed positions. The readings of watts and volts are reliable within about 0·5 per cent. The current readings are less accurate, as the range of the instrument was not very suitable. The source of current was a 37-kilowatt alternator of the author's type, working at 100 periods per second, and at a high E.M.F. The low E.M.F. required for the tests, from 20 to 60 volts, was given by the secondary of a transformer, the primary of which was connected to the alternator. Variations of E.M.F. were obtained by adjustment of the field excitation of the alternator.

There are irregularities in the tabulated readings which are probably not entirely due to errors of observation, but to differences of the conditions under which the tests were made. For example, the iron, when removed from the oven, was allowed to cool, but the exact temperature was not taken, and it certainly was not the same in all cases. In August it would probably be higher than in December. And although the alternator used to supply the testing current was the same in all cases, and was run at the same periodicity, there were differences of condition of the circuit and load which may have had a slight influence on the results.

Sample No. 1.—This consisted of a block built up of stampings arranged as in fig. 1, which shows section and plan, the outside

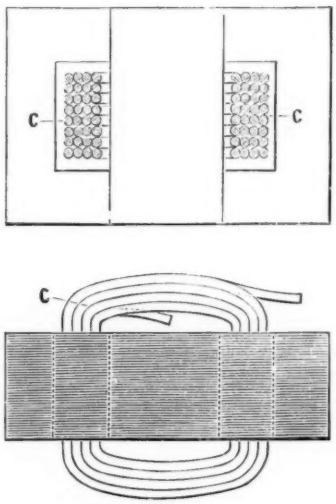


Fig. 1.

dimensions of the plates being 16½ inches by 11 inches. The sheets were 0·014 inch (0·354 mm.) thick, varying slightly; they were built up to a certain thickness with 100 stampings separated by paper, the total weight being about 55 lbs. The winding is shown at C.

Samples Nos. 2 and 3 were made up exactly the same as No. 1, but were taken from different supplies of iron.

They were occasionally removed from the oven, allowed to cool, and then returned to the oven after a test had been taken of the loss of energy with a given magnetisation.

The results obtained from these three samples are given respectively in Tables 1, 2, and 3, and graphically in diagrams 1, 2, and 3. For ease of comparison, the watts are plotted as percentages in all the diagrams.

The magnetising coil in each of these cases consisted of 100 turns of copper strip 0·16 inch by 0·09 inch, having a resistance of 0·15 ohm, or so low as to make the $c^2 R$ loss negligible, as compared with the loss in the iron. For example: with the maximum current used, 0·7 ampère, $c^2 R = 0{\cdot}0735$ watt, the total loss being 29·3 watts.

In the foregoing examples the iron magnetic circuit is not quite continuous; it is interrupted in part by butt joints, and in part by lap joints.

Sample No. 5. In order to eliminate any errors that might conceivably be caused by alterations at the joints, a rectangle was made up as follows:—

A number of iron plates were taken, each 16½ inches by 11 inches by 0·014 inch, there being stamped out from the middle of each plate a piece 11 inches by 5½ inches, as in fig. 2, showing side and edge views. The plates were separated by paper, and bound together by tape. They were then overwound, as in the figure, with a continuous winding, consisting of 140 turns of insulated copper wire 0·049 inch diameter (resistance 0·4 ohm) so disposed, as to magnetise the block almost evenly throughout the magnetic circuit.

The measurements made with this sample are given in Table V. and Diagram 5.

On the occasion of each test, measurements were made at three densities, viz., **B** 2,500, 2,752, 3,050.

The sample was kept in the oven between each set of tests, at the same temperature as the others, that is, an average of about 67° C.

It will be seen that the hysteresis is still rising, the change being about in the same order as in the other samples, showing that the question of joints has no noticeable effect. The change also follows closely the same order, whether measured at 2,500, 2,762, or 3,050 **B**.

Effect of Pressure.—An attempt was made to find if the increase was due directly to heat or to a mechanical condition brought about by the heat.

A possible explanation of the increase of hysteresis suggested itself in connection with the method of construction. In transformers the iron laminæ are usually bolted together very firmly, in order to ensure

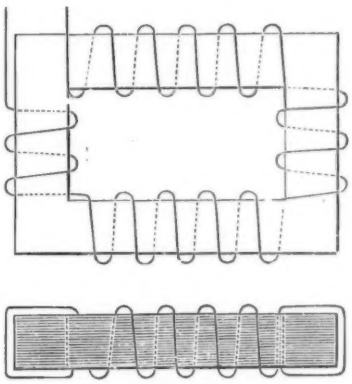


Fig. 2.

good contacts at the magnetic joints, to prevent noise, and for ordinary purposes of mechanical construction. It appeared possible that the expansion of the iron, due to heat, caused the plates to be pressed together more firmly when hot than when cold, and that this state of compression, if long continued, had a hardening effect on the iron, similar to that caused by cold rolling or hammering.

One objection to this explanation was, that as the iron bolts holding the plates together were heated nearly as much as the plates, and therefore expanded nearly as much, the pressure could only vary slightly.

It was thought that in some forms such a gradual hardening might also be caused by the pressure exerted by the weight of the upper plates on the lower ones. But the increase was found where there was no superincumbent weight in transformers in which the plates rested on their sides or edges.

In order to investigate this point, two experiments were tried. The first was with the sample marked No. 5. In order, as far as possible, to avoid any compression, the plates in this sample were not bolted or clamped together, but, as described above, were merely held together by a binding of insulating tape, and by the layer of copper wire with which they were covered. The results given in Table V. do not differ materially from those of Nos. 1, 2 and 3.

An observation which tends to indicate that pressure is not the cause of the change of condition was made some time ago. Different parts of the iron of a transformer, which had been in use some time, were examined, when it was found that the middle portions were rather more affected than the end portions. As the end portions, being most exposed, are least heated, and as in this instance all parts were subject to the same amount of pressure by the clamps or bolts, this observation does not support the supposition that pressure is the cause of the change. As, however, commercial iron varies in its hysteresis, even in the same sheet, the observation is of doubtful value.

A second set of tests is that marked No. 6. In this case the iron used was of the same size as in Nos. 1, 2, and 3, but of smaller amount.

It was arranged with a testing coil in the same manner, but instead of keeping the iron with its coil complete throughout the experiment, the coil was only put on for the tests, and was then removed, the iron being placed in the oven, arranged as a flat block (its upper surface being about 150 square inches), with a weight of about 300 lbs. on it till the next test was made. It was thought that perhaps the slight pressure produced in this way might affect the results. These are given in Table VI. and diagram No. 6, and are markedly different from the tests of Nos. 1, 2, 3, and 5. The increase of hysteresis is greater, although the test has not been so long in progress.

This point deserves full investigation, and the author hopes to obtain further results from tests now in progress.*

Change of Power Factor.—The power factor or ratio of watts to volts × ampères shows an irregular increase in all the tests. This increase in the power factor indicates a possible (but improbable) increase in the eddies, such as would be accounted for by a decrease of the specific resistance of the iron. The author is proceeding to investigate this matter by continuously heating a ring formed by winding a volute of iron ribbon or wire, overwound with a testing coil of copper wire. The ends of the iron being brought out enable measurements of the resistance to be taken, the magnetising losses being measured as in the other samples. †

* Appendix I.
† Appendix II.

Magnetisation not necessary to Production of the Effect.—Having ascertained that neither magnetic nor electric action was necessary to the production of this effect, the author has endeavoured to find whether alternate current magnetisation of iron can be carried on continuously, or for considerable periods, without producing any noticeable change, and, although the evidence is not sufficient to justify a positive statement, he finds that so long as the iron is kept cool it suffers no reduction of permeability. For example, a transformer in regular use for certain testing purposes, and used several hours daily during the last 15 months, has kept its permeability unaltered. It is magnetised at various densities up to about 2,700 B. It is a specially designed apparatus, of large size for the work it has to do (and therefore inefficient and costly), and the temperature of its iron probably never rises more than about 6° to 8° C. above the room in which it is placed. It may be that its daily periods of rest account for the absence of change. This supposition is, however, not supported by other cases where iron which has been in regular use, but with daily periods of rest, has shown the increase of hysteresis very clearly.

Condition not Changed by Repose.—Further, the iron of some transformers which showed this increase, but which for several months have not been used, show no return to their original condition. The author is, therefore, inclined to believe that if periods of repose in some cases prevent the rise, it is because the time of use is not long enough to allow of much increase of temperature.

This part of the subject is being pursued, but for the present the author will only say that, so long as iron is only slightly warmed (even when that warmth is caused by alternate current magnetisation) its permeability remains unaffected.

It may be that repose at a temperature near or below zero, Centigrade, or at a still lower temperature, would have some effect. It appears possible, since continued expansion due to moderate heat can bring about this permanent increase of hysteresis, that continued contraction by moderate cold may bring the iron back to its original condition, or even permanently increase its permeability. The author intends to investigate this point.

The slow increase of hysteresis,* which is the subject of this communication, must not be classed with the immediate effect produced by the moderate heating of iron. When the iron of transformers is heated in working, it at first absorbs less energy than when cool, probably because the increase in its resistance lessens the eddies set up in it. This is the case whether the heating is by ordinary means or by magnetic reversals. It is a temporary effect—the loss goes up again on cooling. If it is kept heated, a slow change takes place, the loss gradually increasing again, from the decrease of permeability caused by heat.† If the temporary reduction of the loss is entirely accounted for by the increased resistance reducing the eddies, it appears to afford a means of separating the losses caused by hysteresis proper, and those caused by eddies. The ordinary measurement of magnetising loss of course gives the sum of these two.

The increase of hysteresis shown in the tests, and resulting from the heating, is somewhat greater than the author has observed in transformers where the heat has been caused by the magnetic and electric losses; possibly this is because in the latter cases the temperature has been somewhat lower.

All the tests show an increase of loss, the maximum apparently not yet having been reached. The tests are being continued.

Conclusions.—The conclusions to which these observations lead, so far as they have gone, are:—

1. The effect is not fatigue of the iron caused directly by repeated magnetic reversals—it is not "progressive magnetic fatigue."
2. Neither magnetic nor electric action is necessary to its production.
3. It is a physical change resulting from long-continued heating at a very moderate temperature.
4. It appears to be greater if pressure is applied during heating.
5. It is not produced when the iron is not allowed to rise more than a few degrees above the ordinary atmosphere.
6. It is similar to the effect produced by hammering, rolling, or by heating to redness and cooling quickly.
7. The iron returns to its original condition on re-annealing.
8. It does not return to its original condition if kept unused and at ordinary atmospheric temperatures, whether the periods of rest are short or long.

(*To be continued.*)

ON THE RETARDATION OF POLARISATION IN DIELECTRICS.‡

By RICCARDO ARNO.

Ewing and Miss Klaassen have shown:—1. That the work, w, consumed by the magnetic hysteresis in iron may be represented as a function of the magnetic induction, b, by means of a relation of the form

$$w = k\, b^{\epsilon},$$

where ϵ and k have values which vary with the variations of the limits of b; and, 2. That the variations of the exponent, ϵ, correspond to the transitions from one to another of the successive stages of the process of magnetisation, and that exactly the relatively high values of ϵ correspond to the initial and final states where the magnetic permeability is small, whilst in correspondence in the intermediate stages where the magnetic permeability is greater the values of ϵ become notably smaller.

On the other hand, by a series of experiments the results of which are given in some former papers I have been led to establish:—1. That in a dielectric cylinder placed in a rotating electric field there is a dissipation of energy, since the cylinder is subjected to a couple which tends to make it revolve in the direction of the same field; and, 2. That the relation between the energy dissipated, W, of the dielectric cylinder and the electrostatic induction, B, in any point whatever of the rotating field is of the form

$$W = K B^{x},$$

where x and K have values which vary in the limits of B; 3. That for paraffined paper the exponent of B in the relation between W and B is respectively equal to 1·83, 1·65, 1·90, according as the values of B experimented with are comprised between 0·06 and 0·17, 0·95 and 2·65, 9·90 and 14·58 electrostatic units C.G.S.

These results, placed in comparison with the experiments of Ewing and Miss Klaassen on the magnetic properties of iron, render clear the analogy which seems to exist between the laws of magnetic hysteresis in magnetic bodies, and the law of the phenomenon which we are studying in dielectrics, and enable us to foresee:—1. That the phenomenon of the rotation of a dielectric cylinder in a rotating electric field must be due to a retardation with which the polarisation of the dielectric follows the rotation of the electric field, exactly as in a rotating magnetic field an iron cylinder divided in such a manner that Foucault currents cannot be produced in it, is set in rotation on account of the retardation with which the magnetisation of the iron follows the rotation of the magnetic field; 2. That the values of the exponent, x, in the relation between W and B has to correspond to the various stages of the process of polarisation, and that, in like manner as what happens in the magnetisation of magnetic values, the values of x, relatively greater, have to correspond with the initial and final states and those relatively small to the intermediate stages.

A series of new researches, the results of which are given in this paper, confirm these previsions.

The apparatus used and the dielectric cylinder experimented with, are the same which served in the researches, the results of which have been given in the last of my papers above referred to. The frequency of the alternating current was equal to 40. The distance from the plate enclosing the space in which the rotating electric field is generated, was 4·4 cm., and the distance from the mirror to the scale, 2,660 mm. The dielectric cylinder of paraffined paper experimented with had the height of 26 mm., the external diameter 30 mm., the thickness 1 mm., and the weight 2,011 grams.

Under these conditions and in the succession of 70 various values of the electrostatic induction, B, included between 0·030 and 5·30 electrostatic units, C.G.S.; there were executed as many experiments which are grouped by tens in seven series, each of which refers to a given sensitiveness of the apparatus. To obtain, therefore, for each series the same importance of the measurements, I have arranged, by means of transformers of suitable proportion, the matter in such a way that the value of the electrostatic induction in electrostatic units, C.G.S., had to be deduced in each experiment from the measurement (made with a Cardew voltmeter) of a difference of potential always comprised between the same limits (40 and 112 volts).

In the first columns of the following table are given the results of my experiments, in each of which are registered, respectively in the 2nd, 3rd, and 4th column the difference of effective alternative potential, V, as indicated by the voltmeter, the electric induction, B, and the reading, d, taken with the telescope. The last of which is proportional the work, W, in ergs done by the deflecting electric force done in a unit of time, referring to seven different sensibilities of the instrument, obtained by varying either the weight, P, supported in a bifilar suspension, or the length of the same, and the superior distance, a, and the inferior, b, between the two wires forming the said suspension.

* This effect may have an important influence on the reliability of measuring instruments having iron portions magnetised by alternate currents. The constants of such instruments may gradually fail.

† Appendix III.

‡ *Transactions* of the Royal Lyncean Academy *Rendiconti della Reale Accadomia dei Lincei*. Read November 18th, 1894.

PROCEEDINGS OF SOCIETIES.

Physical Society.

Extra meeting, Friday, January 11th, 1895, in the physical laboratories of University College (by invitation of Prof. Carey Foster), Prof. Rücker, president, in the chair.

Prof. Ramsay read a paper by himself and Miss Dorothy Marshall on The Measurement of Latent Heats of Vaporisation of Various Organic Liquids.

The liquid to be examined is placed in a small flask with a narrow neck, and within this is a platinum wire, which has its two ends fused through the bottom, so as to be capable of conveying an electric current, and thus giving heat to the liquid. The flask is completely enclosed in a jacket, which is filled with the vapour of liquid of the same kind, and kept briskly boiling in a somewhat large flask. Before the current is turned on, the vapour jacket is kept going for some time, so that the liquid in the flask is raised just to its boiling point, but no appreciable evaporation takes place. As soon as the current is turned on, boiling commences, and as the temperature of the liquid

cannot be further raised, all the heat developed in the wire is expended in producing evaporation. By weighing the flask before and after, the mass of liquid vaporised is determined. So far the authors have only used the method for comparative determinations. Two arrangements of the kind described are placed side by side, and the same current is sent through their two wires, which are joined in series and have approximately equal resistances. The actual values of the resistances are found while the current is flowing, and allowance is made for their inequality. The ratio of amounts of heat expended on the two liquids, divided by the ratio of the masses vaporised, is equal to the ratio of their latent heats. As a standard liquid of known latent heat, the authors prefer alcohol to water, as it vaporises more easily and with less bumping. The determinations made by this method agree well with those of other observers, but the authors' object is to obtain values correct within about ½ per cent. for a large number of liquids, rather than a highly accurate value for any one substance.

In reply to Mr. Griffiths, the authors stated that the platinum wire was found to rise about 20° above the temperature of the liquid, and Mr. Griffiths said that his experience had been similar. He did not see why a very high degree of accuracy should not be obtainable by the method.

Prof. Rucker expressed his admiration for the work, and thought it justified by the fact that the results accorded more nearly with theory than those of other observers.

Mr. G. U. Yule then gave a brief outline of his paper, On the Passage of an Oscillator Wave-Train through a Plate of Conducting Dielectric.

By a conducting dielectric, the author means a substance whose conductivity and dielectric capacity are both of importance in the case under discussion, and the paper is mainly an investigation of the following problem: A train of plain electro-magnetic waves falls at normal incidence on an infinite parallel-sided plate of conducting dielectric, whose thickness is finite, and at the first face of the plate, the amplitude of the vibration vector in the incident train is zero up to a certain instant, and then becomes equal to an harmonic function of the time, multiplied by an exponential function with negative index. To find what proportion of the energy of the whole incident train is reflected back, what proportion is transmitted through the plate, and what proportion absorbed. At successive incidences of reflected and re-reflected wave-trains upon the two bounding faces of the plate, the amplitudes and phase-changes of reflected and transmitted portions have to be taken into account, and the resulting infinite series of terms have to be summed. The analysis is very long, but the results obtained are exact. Curves are given, showing (for special numerical values of the constants of the problem) the quasi-periodic variation of the amounts of energy transmitted and reflected, as the thickness of the plate is increased from zero up to a high value. Other curves are given, showing the effect of varying the dielectric constant and the conductivity of the plate, and the difference between a "damped" and an "undamped" wave-train in regard to intensity of reflected and transmitted portions. The author compares his calculated results with measurements obtained in the case of oscillator waves travelling along a double-wire circuit about 100 metres in length; the wires at the middle of the circuit being run through a jar containing distilled water, alcohol, or a very dilute electrolyte. The necessary corrections, however, are difficult and uncertain, and the author has not found it possible to deal with them in a satisfactory way.

A letter from Dr. E. H. Barton was read, emphasising the necessity for taking into account the damping in the oscillator train, and at the same time pointing out why, in his opinion, the corrections applied by Mr. Yule were inadequate, and failed to yield intelligible results.

Prof. Rucker congratulated Mr. Yule on his work, and on the importance of the results he had obtained. In returning the thanks of the Society to Prof. Carey Foster for the invitation to meet in University College, he expressed the pleasure he had felt in observing the extent and completeness of the laboratories. Hitherto London had been behind the provinces in this matter, and it was gratifying to find that students in London had now such opportunities for practical instruction in physics. The papers which had been read at that meeting were a proof that good use was being made of the laboratories for the purposes of research. The educational experiments they had seen in the laboratories were excellently devised, and he hoped that many of them would become a part of the regular course of instruction in the country.

Prof. Foster briefly replied.

Ordinary Meeting.—January 25th, 1895.

Mr. Medley concluded the reading of a paper by Prof. Ayrton and himself, on Tests of Glow Lamps, which was commenced at a former meeting. With the newer lamps employed in these tests, it was found that candle-power, current, and candles per watt, all rose as the lives of the lamps increased. The authors, being surprised at this result, took care to satisfy themselves that the effect observed was due neither to change in the resistance of their manganin potentiometer strip, nor to uncertainty of contact at the sockets of the lamps. Starting again with new lamps, they found that in all cases the light given out was greater after the lamps had been glowing for some time than it was when they were new. In the earlier tests, a considerable falling off in candle-power had always taken place after the lamps had been running for some time. Further, while the globes of the earlier lamps were always much blackened, even after a run of a few hundred hours, and so became comparatively useless long before the filament broke, the Edison-Swan lamps now examined showed hardly any blackening, even when the filaments lasted over 1,300 hours. The rise in candle-power was always accompanied by a rise in current, which was, however, proportionally much smaller, so that the consumption of power per candle was actually less after the lamp had been running 50 hours than it was at the beginning. Among the conclusions drawn by the authors were the following:—(*a*) When a group of Edison-Swan lamps, marked 100 – 8, are run at 100 volts, and each lamp as its filament breaks is replaced by a new one, it may be expected that the light given out will never subsequently be as small as when all the lamps were new; (*b*) An Edison-Swan lamp, marked 100 – 8, when run at 100 volts will give an average illumination of about 10 candles, and will absorb on an average power of about 4·3 watts per candle, so that such a lamp must be regarded as a 43-watt lamp, and not a 30-watt lamp, as is frequently stated; (*c*) The maximum rise of light recorded during the life of any lamp was 45 per cent.; (*d*) With lamps of the type examined, there is no point at which it becomes economical to discard a lamp before its filament actually breaks; (*e*) No marked economy can be gained by overrunning such lamps (*i.e.*, by using pressures exceeding 100 volts).

Prof. Ayrton mentioned that the improvement in glow lamps, after running for some time, had been attributed to an improvement in the vacuum. Experiments made on new and used lamps by means of an induction coil, showed that the more a lamp was used, the better the vacuum became; but he (Prof. Ayrton), though at first inclined to adopt this explanation, had since found that though in all the lamps examined the progressive improvement of the vacuum was equally marked, the increase in candle-power varied between very wide limits, being very considerable in some lamps, and hardly perceptible in others.

Prof. Rucker asked if it made any difference to the life of a lamp whether it were kept running continuously until the fibre broke, or were run for periods of a few hours, alternating with intervals of rest. The latter case would more nearly correspond with the conditions obtaining in practice.

Prof. Ayrton replied that the lamps were kept running during the night, and were disconnected during the day.

Annual General Meeting.—February 8th, 1895.

The chair was taken by the retiring President, Prof. Rücker.

Mr. S. Skinner read a paper On The Tin Chromic Chloride Cell.

He said that his attention had been attracted to the cell by an account published by Mr. Case, of New York. The cell had been stated to give no E.M.F. at ordinary room temperatures, while it gave a considerable E.M.F. at 100° C. The author had found that when the cell was directly connected up to a galvanometer there was no current at ordinary temperatures, and some current at 100° C., but when he had measured the E.M.F. by Poggendorff's method, he had found ·44 volt at 15° C., and ·40 volt at 97° C. The cell as originally described consists of a tin plate and a platinum plate immersed side by side in a solution of chromic chloride; when the temperature of the cell is near to 100° C., and the poles are connected, the following reaction occurs:

$$Cr_2 Cl_6 + Sn = 2\ Cr\ Cl_2 + Sn\ Cl_2;$$

and when the poles are disconnected, and the cell cooled, the reverse change takes place. The author prefers to use as electro-positive metal an amalgam of tin and mercury instead of a tin plate, so that when the tin precipitated during cooling falls to the bottom of the solution, it is re-dissolved in the mercury, and the cell has regained its orginal state. When silver nitrate solution is added to chromic chloride, only two-thirds of the chlorine comes down as silver chloride, and this has led the author to suppose that the proper formula for chromic chloride is $2\ Cr\ Cl\ Cl_2$. Hence he works out the electrolytic action by means of a Grotthus chain.

Prof. Rucker asked whether a change of polarisation would explain the behaviour of the cell at different temperatures?

Prof. Carey Foster asked whether the reversed chemical action, on cooling from a high temperature, were accompanied by a reversed E.M.F.?

Mr. Skinner said, No; the tin was precipitated throughout the solution, and not at the surface of the tin plate, so that no E.M.F. of the kind was to be expected.

Mr. Appleyard thought that Prof. Minchin had used tin chloride cells with two tin plates for electrodes; the cells only working when one plate was illuminated.

Mr. Trotter wished to know whether heating the cell supplied energy to it, or simply removed an obstacle in the form of polarisation?

Mr. Skinner thought that heating acted by removing an obstacle.

Captain Abney: And so doing work.

NEW PATENTS—1895.

2,392. "Improvements in arc lamps specially applicable for lantern purposes." F. W. Branson. Dated February 4th.

2,394. "Improvements in primary batteries." H. Levetus, E. M. Levetus, and W. Rowbotham. Dated February 4th.

2,430. "Improved means for insulating electric conductors." G. G. M. Hardingham (Communicated by the firm of Felten & Guilleaume, Germany.) Dated February 4th.

2,446. "Improvements in apparatus for the reflection of electric or other light applicable for use in connection with buoys at sea, signalling, advertising, and other purposes." J. Boyes. Dated February 4th.

2,450. "Improvements in the bulbs of incandescent lamps." A. L. Fyfe. Dated February 4th.

2,492. "Improvements in submarine telegraph cables." W. S Seaton. Dated February 5th.

2,541. "Improvements in electric burglar alarms." L. H. Hordern. Dated February 5th.

2,558. "Improvements in electric arc lamps." O. L. Peard and A. Essinger. Dated February 5th.

2,561. "Improved means and appliances for regulating the feed of carbons in electric arc lamps." J. Jeffreys and J. Lea. Dated February 5th.

2,570. "Improvements in chandeliers, electroliers, pendant hanging lamps, and brackets for gas, oil, or electric light." C. Meason and T. Ford. Dated February 6th.

2,604. "Improvements in electric arc lamps and their connections." R. E. B. Crompton. Dated February 6th.

2,606. "Electrical and pneumatic apparatus for scraping, cleaning, and lubricating the hulls of ships when afloat or in dock." A. W. Gatfield and W. R. Clark. Dated February 6th.

2,626. "Electro-copper sheating." J. H. Cox. Dated February 6th.

2,650. "Improvements in electric bells or gongs." S. Quincey. Dated February 6th.

2,659. "Improvements in electrical resistances." Sir C. H. A. F. L. Ross, Bart. Dated February 7th.

2,675. "Improvements relating to insulators for overhead electrical conductors." A. Wiglesworth. Dated February 7th.

2,740. "Improvements in dynamo brushes." T. Fryer and A. E. Channon. Dated February 7th.

2,804. "Metallic mixtures and alloys for effecting electro-chemical decompositions." O. Imray. (Communicated by L. Diehl, Germany.) Dated February 8th.

2,805. "To regulate or assimilate the movements of electrically-connected mechanical instruments or machines, more particularly wheels or other bodies revolving upon axes, and to diminish variations in the movements or speed of the same by means of electrical impulses." R. J. Crowley, H. W. C. Cox, and C. F. Leighton. Dated February 8th.

2,808. "Improvements in electric cables." W. P. Thompson. (Communicated by F. Clouth, Germany.) Dated February 8th.

2,816. "Improvements in secondary batteries." F. King. Dated February 8th.

2,817. "Improvements in or connected with electrical conductors for heating purposes." H. Edmunds. Dated February 8th.

2,827. "Improvements in primary batteries." C. L. Charlopin, V. M. Cornely, and L. C. H. Dautelf. Dated February 8th.

2,874. "Improvements in or connected with electric lamps for surgical operations." W. H. Buckley. Dated February 9th.

2,883. "A new or improved process to render the liquid of primary or secondary batteries motionless." A. Lesquoy. Dated February 9th.

2,894. "Improvements in the production of zinc chloride and in the generation of electricity." R. W. Hill. Dated February 9th.

2,914. "Improvements in systems of electrical distribution." J. Devonshire. (Communicated by C. P. Steinmetz, United States.) Dated February 9th. (*Complete.*)

2,915. "Improvements in systems of distribution by alternating currents." J. Devonshire. (Communicated by C. P. Steinmetz, United States.) Dated February 9th. (*Complete.*)

2,916. "Improvements in systems of electric distribution." J. Devonshire. (Communicated by C. P. Steinmetz, United States.) Dated February 9th. (*Complete.*)

2,917. "Improvements in systems of electrical distribution." J. Devonshire. (Communicated by C. P. Steinmetz, United States.) Dated February 9th. (*Complete.*)

2,918. "Improvements in windings for dynamo-electric machines." J. Devonshire. (Communicated by C. P. Steinmetz, United States.) Dated February 9th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

18,428. "Improvements in electric telegraphs, and mechanism used in connection therewith." G. Draper and A. Fraser. Dated October 2nd. The inventors employ type printing telegraphs in which the character to be printed is determined by the time of arrival of single impulses—this time having a relation to the uniform motion of the receiving instrument. 12 claims.

25,009. "Electric heater, and its application to electric cigar lighters." F. W. Schindler. Dated December 29th. The heater consists of a cylindrical or otherwise shaped block of refractory insulating material provided with perforations through which passes the electric conductor. 10 claims.

1894.

6,212. "Improvements in and relating to electric railways." M. A. Cattori. Dated March 27th. The object of the invention is to provide a conductor or conductors which will present a high degree of safety against short circuits, to construct such conductors in sections and yet avoid sparking when the electrical connection between two sections is interrupted, to utilise one or both rails of an existing track as electrical conductors, and to provide sectional conduits that will be strong and comparatively light, and adapted to be used either in connection with special rails, or with the ordinary track rails, thereby affording a convenient means of converting an existing railway into an electric railway. 17 claims.

13,377. "Improvements in process and apparatus for electrolytically treating salts in solution or in molten state." P. Jensen. (A communication from abroad by H. C. F. Störmer, of Christiania.) Dated July 10th. Consists in utilising a flowing liquid or molten substance as diaphragm for separating the two electric fields from each other. 4 claims.

13,762. "Improvements in and relating to electric railways." C. D. Jenney. Dated July 17th. Relates to that class of electric railways in which a conduit is provided, similar to such as are provided for cable railways; and it consists in certain novel construction whereby such a railway is produced, having a high degree of efficiency combined with durability and economy of operation. 7 claims.

14,651. "Improvements in electrical heating devices." G. C. Dymond. (A communication by J. A. G. Trudeau, of Ottawa.) Dated July 31st. Consists essentially in an arrangement whereby the object to be heated is itself made to constitute the core of a coil through which alternating currents of electricity are passed. 7 claims.

14,922. "Apparatus for electrically operating semaphore signals." W. Fiedler. Dated August 3rd. The object of the invention is to provide a working apparatus, which attached to the existing signals on the line, gives the possibility, through a corresponding coupling with the signal-body, as also through a peculiar arrangement of the separate parts to work the signals by means of an electric current thus making it possible to work these signals directly from any given distance. 1 claim.

15,900. "Improved means for preventing variations in the regulation of shunt arc lamps for alternating currents." Siemens Bros. and Co., Limited. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated August 21st. Claim:—In shunt arc lamps for alternating currents, the introduction of a non-inductive resistance in the circuit of the shunt electro-magnet, for the purpose of obviating the variations in degree of the shunt current tension at which the regulating device operates.

16,002. "Improvements in apparatus for refining metal by electrolysis." H. A. House, sen., H. A. House, jun, and R. R. Symon. Dated August 22nd. The object of the invention is to separate, from the impure or base bullion, the silver in a pure state, and to recover the other metals by the same operation, in a more economical and practical manner than has heretofore been done. 5 claims.

16,243. "Improvements in the electric propulsion of cars." A. H. Brintnell. Dated August 25th. Consists essentially of a system in which the motor is comprised partly of armatures attached to or forming part of the frame of the car and of field magnets located in pairs at desired distances apart between the rails of the track, so that a longitudinal pull is given to the armatures, so as to draw the car forward or rearward as desired, mechanism being arranged for throwing in the current into the field magnets. 10 claims.

16,825. "Electro-magnetic car brake and traction device." R. T. Murray and C. M. Allen. Dated September 4th. Consists in the employment of a powerful electro-magnet or magnets through which a direct attraction and frictional resistance may be had with the surface of the track over which the car is passing, or by which the tractile power of a motor may be increased. 3 claims.

17,281. "Improved apparatus for converting alternating electric currents into direct currents." W. J. Still. Dated September 11th. Consists essentially in securing on a shaft a cylinder of insulating material around which are secured metal rings with lateral teeth or projections which are arranged to co-act with a series of brushes by which the alternating current is changed to a constant current, the cylinder being rotated by a motor arranged in a fixed relation to the transmuting cylinder. 12 claims.

17,284. "Improvements relating to the transformation and distribution of electric currents." J. F. McElroy. Dated September 11th. The inventor places at the central station a high potential alternating dynamo or generator, and at the local station or stations he places a converter, consisting of a series of induction plates, separated from each other by a non-conducting substance, and alternately connected into two sets, one set being connected to one pole of the dynamo, and the other set being connected to the translating devices at the local station. 5 claims.

17,296. "Improvements in armatures for dynamo-electric machines." W. R. Lake. (Communicated from abroad by R. Eickemeyer, of New York.) Dated September 11th. Consists in covering the armature drum with a wire winding in divisions, each of which is made up of a group of two or more individual members or coils, each having a long side and a short side lying along the periphery of the drum in two or more layers, and inclined ends lying across the heads of said drum in flattened webs of a single thickness of wire, said long and said short sides of the individual coils in each division or group being separated on the periphery of said drum by spaces which receive respectively the short and long sides of other similar individual coils belonging to other similar groups, and said long sides in each group being arranged on the periphery of the drum in the reverse order of the short sides of the same group. 2 claims.